Quality Management Practices Among A/E Organizations

by

Gulam Farooq

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

December, 1997

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700 800/521-0600

QUALITY MANAGEMENT PRACTICES AMONG A/E ORGANIZATIONS

BY

GULAM FAROOQ

A Thesis Presented to the

FACULTY OF THE COLLEGE OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

DECEMBER 1997

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
DHAHRAN 31261, SAUDI ARABIA

COLLEGE OF GRADUATE STUDIES

This thesis, written by **Gulam Farooq** under the direction of his thesis advisor and approved by his Thesis Committee, has been presented to and accepted by the Dean of the College of Graduate Studies, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in CONSTRUCTION ENGINEERING AND MANAGEMENT.

Thesis Committee

25/3/93

Dr. Abdulaziz A. Bubshait
(Thesis Advisor)

Dr. M. Osama A. Jannadi
(Member)

Dr. Sadi A. Assaf
(Member)

Dr. M. Osama A. Jannadi
(Department Chairman)

Dr. Abdullah M. Al-Shehri
Dean, College of Graduate Studies

22-4-93
Date

بسم الله الرحمن الرحيم

This Work is Dedicated to My Parents

and to

All The Others Who Had a Positive Influence on My Life

ACKNOWLEDGEMENT

Thanks are due to Almighty Allah for His Grace and Blessings bestowed upon me.

I would like to acknowledge my thesis chairman Dr. Abdulaziz A. Bubshait for his contionous support and encouragement in my thesis work and during my stay in KFUPM. I would also like to acknowledge the committee members Dr. Osama A. Jannadi and Dr. Sadi A. Assaf for their guidance, support, and trust towards me.

I would also like to acknowledge the support, and encouragement of my family and friends through out my stay in KFUPM.

I would like to extent my appreciation to the design organizations who took time to participate in this study. Last but not least acknowledgement is due to King Fahd University of Petrcleum and Minerals for the support of this research.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

THESIS ABSTRACT

FULL NAME OF STUDENT	GULAM FAROOQ
TITLE OF STUDY	QUALITY MANAGEMENT PRACTICES AMONG A/E ORGANIZATIONS
MAJOR FIELD	CONSTRUCTION ENGINEERING AND MANAGEMENT
DATE OF DEGREE	DECEMBER 1997

In this study seventy statements measuring fifteen quality management areas (QMA) were surveyed among the local A/E consulting organizations. The areas measured are organizational quality policy, designer qualification, employee training and education, design planning, design inputs, design process, interface control, design review, design changes, subcontractor control, document control, design mainatainability, computer usage, working relationship, and quality audit. The study determined the prevalency of the above fifteen QMA, and the importance given to these QMA. The study also determined the quality of service provided by the local A/E consulting organizations through these QMA.

The results of the study revealed design review, design changes, document control, and design planning as the most prevalent QMA. While performance quality audit, employee training and education, working relationship, and interface control were the least prevalent QMA. Design review, design changes, designer qualification, and design inputs were given the highest importance ratings. While employee training and education, working relationship, performance quality audit, and interface control were given the lowest importance ratings. The average service quality of the respondent organizations was rated as 'good'.

MASTER OF SCIENCE DEGREE

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
Dhahran, Saudi Arabia

December 1997

خلاصة الرسالة

اسم الطالب الكامل: غلام فاروق

عنوان الدراسة : ممارسات إدارة الجودة في المكاتب الهندسية

التخصص : هندسة و إدارة التشييد

تاريخ الشهادة: ديسمبر ١٩٩٧/م

لمعرفة مستوى إدارة الجودة في المكاتب الهندسية تم استخدام استبيان مكون من سبعين جملة لقياس خمس عشر ممارسة من إدارة الجودة . الممارسات التي قيست هي: قوانين تنظيم الجودة ، مؤهلات المصمم ، برنامج تثقيف وتدريب الموظفين ، تخطيط التصاميم ، مدخلات التصاميم ، عمليه التصميم ، ضبط المتداخلات ، مراجعة التصاميم ،طريقة عمل التغييرات في التصاميم ، ضبط مقاولين الباطن ، ضبط الوثائق ، قابلية التصميم للصيانة ، استخدام الحاسب الآلي ، علاقات العمل ، وبرنامج تدقيق الجودة . وحددت الدراسة مقدار انتشار هذه الممارسات الخمس عشر والأهمية المعطاة لهذه الممارسات . وحددت الدراسة أيضاً الجودة النوعية للخدمات المقدمة من المكاتب الهندسية الاستشارية المحلية من هذه الممارسات .

و قد دلت الدراسة على أن ممارسات الجودة النوعية الأكثر إ انتشاراً في المكاتب الهندسية هي: مراجعة التصاميم ، عمل التغييرات في التصميم ، ضبط الوثائق والتخطيط للتصميم. و الممارسات الأقل انتشاراً هي . تدقيق الجودة . تدريب وتعليم الموظفين ، علاقات العمل ، والتحكم في العلاقات المتداخلة بين الأقسام . ومن حيث الترتيب حسب الأهمية فإن مراجعة التصاميم ، تغيير التصاميم ، مؤهلات المصممين ، ومداخلات التصميم جاءت في المراتب الأولى حسب الترتيب . و الممارسات التي أعطيت أقل أهمية هي تدريب وتعليم الموظفين ، علاقات العمل ، تدقيق الجودة ، والعلاقات المتداخلة بين الأقسام.

درجة الماجستير في العلوم

جامعة الملك فهد للبترول والمعادن

الظهران – المملكة العربية السعودية

ديسمبر / ١٩٩٧

CHAPTER 1

INTRODUCTION

1. 1 GENERAL

The increasing competition between organizations and the growing satisfaction demands of the customers has prompted many of the organizations to redefine their management principles to ensure their survival. The emergence and the recent importance being given to the principle of Quality Management (QM) has led to serious rethinking by organizations looking for ways to stay competitive.

Quality in construction is defined as the conformance to requirements, as defined by the owner, A/E, contractor, and the regulatory agencies (ASCE 1990). The objective of meeting these requirements rests on the A/E and contractor organizations. There can be no doubt that the A/E organizations bears the greater burden of ensuring quality as it defines the requirements of the owner in the form of drawings and specifications to the contractor. Any deviations in defining the owner requirements at this stage can lead to increased costs in their rectification. Studies (Ransom 1987; Burati et al 1992) show that design deviations account for about sixty percent or more of construction project

deviations. The costs due to poor quality in design and engineering have been estimated at about twelve percent (Burati et al 1992) and eight percent (Trainor 1983) of the total project cost.

Thus to ensure quality in the constructed project it is vital to concentrate on the area, i.e. the A/E organization, where quality management practices can bring about the greatest beneficial affect. This investigation will determine the prevalence of quality management practices among the local A/E organizations, and hence assess the quality of the services provided by the local A/E organizations.

1. 2 SIGNIFICANCE OF THE STUDY

The increasing competition and growing quality awareness in the construction industry has prompted a lot of research into determining the ways to improve the quality of construction. These researches revealed the lack of quality by the A/E as the major reason of lack of quality in the finished product. The importance of determining the QM practices among the A/E organizations cannot be more stressed. This study by increasing the awareness of quality management practices among the local A/E organizations can increase the service quality of the A/E. With organization seeking ways to reduce wasteful costs this study could be used as an aid to build a framework for implementing a

QM system as per the local organizational characteristics. This study can also be used as an aid by competing A/E organizations seeking ways to improve their services by making them aware of their deficiencies.

1. 3 OBJECTIVE

Towards this purpose this study sets out to investigate the quality management (QM) practices prevalent among the A/E organizations in the Eastern Province of Saudi Arabia. The objective of this study can be formulated as seeking the answers to the following questions:

1. What are the QM practices prevalent among the A/E organizations?
2. What areas of the QM system, e.g. organizational quality policy, design control, design review, document control, working relationship, audit, etc., are practised?
3. To what extent are the different areas of the QM system developed?
4. What is the quality of service provided by the A/E organizations?

1. 4 SCOPE AND LIMITATIONS

The study is limited to the A/E consulting organizations in the Eastern Province of Saudi Arabia. The organizations are those so classified by the Chamber of Commerce. The study is limited to determining the design QM practices outlined in Appendix I.

CHAPTER 2

LITERATURE REVIEW

2. 1 GENERAL

Any topic related to QM and its practices is not complete if the quality improvement programs of Philip B. Crosby, W. Edwards Deming, and Joseph M. Juran are not mentioned.

Crosby's (1979) fourteen step quality improvement program is as follows:

1. Management Commitment
2. Quality Improvement Team
3. Quality Measurement
4. Cost of Quality Evaluation
5. Quality Awareness
6. Corrective Action
7. Establish an Ad Hoc Committee for the Zero Defects Program
8. Supervisor Training
9. Zero Defects Day
10. Goal Setting
11. Error Cause Removal

12. Recognition
13. Quality Councils
14. Do It Over Again.

Deming's fourteen points is simply a list, unlike Crosby's fourteen point which are in chronological order, and as such they have evolved over time and have been restated (Fox 1993). Deming's fourteen steps as stated by March (1996) are as follows:

1. Create constancy of purpose for improvement of product and service
2. Adopt the new philosophy
3. Cease dependence on mass production
4. End the practice of awarding business on price tag alone
5. Constantly and forever improve the system of production and service
6. Institute modern methods of training on the job
7. Institute modern methods of supervising
8. Drive out fear
9. Break down barriers between departments
10. Eliminate numerical goals for the work force
11. Eliminate work standards and numerical goals
12. Remove barriers that hinder the hourly workers
13. Institute a vigorous program of education and training
14. Create a structure in top management that will push every day on the above thirteen points.

The ten steps in the quality improvement process as perceived by Juran are (Fox 1993):

1. Build awareness of the need and opportunity for improvement
2. Set goals for improvement
3. Organize so as to reach the goals
4. Provide training
5. Carry out projects to solve problems
6. Report progress
7. Give recognition
8. Communicate results
9. Keep score
1. Maintain momentum by making annual improvement part of the regular systems and procedures of the company.

2. 2 QUALITY MANAGEMENT

The importance of a quality management in any organization is evident from the emphasis given by Crosby, Deming, and Juran, and cannot be more stressed. Crosby (1979) states that "quality management is systematic way of guaranteeing that organized activities happen the way they are planned. It is a management discipline concerned with preventing problems from occurring by creating the attitudes and controls that make prevention possible".

Lascelles and Dale (1988) suggest that the basic core of the philosophies of Crosby, Deming, Feigenbaum, Juran, and other quality advocates is the concept of adopting quality as a fundamental business strategy permeating the culture of the entire organization.

Lakhe and Mohanty (1994) state that the efforts to adopt QM will succeed only if a cultural change is brought about. They also suggest four points as an approach for adopting the QM philosophy:

1. Develop a vision
2. Promote a policy on quality
3. Create a total quality-oriented culture
4. Training and education.

Ebrahimpour (1988) in his study of quality management approaches in ten American and Japanese organization in the United States recognized that top management commitment to quality and emphasis by employees on improving quality are the hallmarks of a successful quality management approach.

Longenecker and Scazzero (1993) in a case study identified the causes for the failure of a QM program in a medium sized manufacturing organization in the United States as:

1. Failure of management to create a climate for quality by adjusting its style and ongoing management principles
2. Management failure to create a work environment which was conducive to quality improvement from the workers perspective.

Glover (1993) points out that a successful QM system becomes the way of life for the organization and its people. Therefore management should stress to reinforce the management and employee behaviours that reflect QM values.

Harber et al (1993) state: "Thus when an organization adopts QM, as with other major organizational change programs, a cultural change is also necessary for a successful implementation. In particular, the move to an emphasis on quality of products and services usually requires a significant change in organizational values and leadership styles".

The ten features that determine the extent of quality culture in an organization, and thus vital for any QM implementation program, stated by Johnson (1993) are:

1 ***Top-down leadership.*** Leaders know where they are going, and they are taking their people with them.
2. ***Vision.*** A clear image is provided depicting exactly where the organization is going, what plans, objectives, and goals are required to get there, and the benefits employees can expect when goals are achieved.

3. ***Customer focus***. Satisfying both internal and external customers is a primary part of all mission considerations.
4 ***Employee well-being***. Employee well-being is considered in the decision making processes and efforts are made to strike a positive balance between this and other important factors.
5 ***Performance management system.*** Employees are selected for quality, trained, appraised against a standard, and recognized for their achievements.
6. ***Reward system***. Employees are rewarded based on accomplishments rather than seniority, longevity, or a subjective standard.
7 ***Communications system***. Communications are open and employees know what is occurring and why.
8 ***Roles and relationships***. Roles are supportive rather than directive, where possible, and relationships up and down the chain are designed to encourage teamwork rather than conflict.
9. ***Structure***. The structure is discretionary allowing more employee input into operations and process input.
10. ***Teamwork***. Lone Rangers are out and teams are in. The rewards system supports team efforts.

From the above discussion it can be understood that any successful implementation of a QM practice consists of two aspects the people and the process. While the people aspect of QM is vital for the success of any QM practice it is beyond the scope of this study. The process management aspect is

the most appealing and easily understandable to the A/E professionals. The A/E professionals are quick to grasp and implement quality management techniques in varying levels although many do not term such practices as a part of quality management (Predpall 1994; Saarinen and Hobel 1990). Predpall (1994) states: "*It is particularly important to provide specific tools that can be applied directly to employee work processes. ... Otherwise, employees may not see the difference between quality-improvement principles and their own work*".

The proper implementation of quality principles in the process, besides being easier to practice, will also bolster the morale and confidence of the organization thus allowing for an easier follow-up implementation of QM in the people aspect.

2. 3 QUALITY IN THE DESIGN PROCESS

An A/E consulting organization is the medium through which the owner states his/her requirements and objectives to the contractor. Thus the consulting organization has the triple task of ensuring that it has collected all the information necessary for meeting the owner's requirements, has understood the said information and processed it correctly into the form of drawings and specifications, and that the contractor is able to clearly understand and implement the owner's requirements through the drawings and specifications.

Any shortfall in fulfilling these tasks can lead to quality deviations in the complete project due to faulty design. Ransom (1987) reported a study by the Building Research Service (BRE) in which the causes of failures were analyzed to indicate whether they were due to faulty design, poor execution, the use of poor materials, or unexpected user requirements. Faulty design was taken to include all cases where the failure could be attributed to not following the established design criteria; the percentage of failures, with some overlap between these categories, was found to be 58%, 35%, 12%, and 1% respectively.

Burati et al (1992) collected quality deviation data from nine construction projects. The data was collected after the construction phase of the projects to identify the direct costs associated with work redesign, repair, and replacement. The data indicated that deviations on the project accounted for an average of 12.4 percent of the total project costs. Furthermore, design deviations averaged 78% of the total number of deviations, 79% of the total deviation costs, and 9.5% of the total project cost. The construction deviations averaged 16% of the total number of deviations, 17% of the total deviation costs, and 2.5% of the total project cost. These values are conservative as they considered only the direct costs, but they are indications of the impact of design quality on the project. Other studies (Kirby et al 1988; Morgen 1986) have identified the three major causes of the contract modifications as design deficiencies, user requested

changes, and unknown site conditions. These studies have also revealed that 56 percent of all contract modifications are to correct design deficiencies.

To be able to control and overcome the deviations in design the A/E consulting organization needs to implement QM practices in its process. With this in mind it is the objective of this study to determine the prevalence of the QM practices, as outlined in Appendix I, in the design process of the consulting organizations. The research will then assess the quality of the service provided by the consulting organizations.

2. 4 PREVIOUS STUDIES

A study by Al-Shiha (1993), into the effects of faulty design and construction on building maintenance, revealed that nine of the top fifteen factors affecting the maintenance work fell under the responsibility of the A/E organization. The list of these 15 factors and their responsibility as defined by Al-Shiha (1993) are given in Table 2.1.

In a study by Bubshait and Al-Abdulrazzak (1996), a survey was conducted to assess the extent of eleven major design quality management activities utilised by the local engineering consulting offices. It was determined that job training. peer review, and establishment of an incentive system were the most neglected QM activities in the A/E organizations.

Table 2.1. Design and Construction Factors Affecting Maintenance (Al-Shiha 1993)

Defect Factors	Responsibility	Rank
Inadequate structural design such as foundation	A/E	1
Hiring unqualified designers	A/E	2
Not complying with specification	Contractor	3
Not relating exterior material selection to climatic condition	A/E	4
Inadequate water proofing and drainage	Contractor	5
Unqualified work force	Contractor	6
Inability to read drawings	Contractor	7
Ignoring aggressive environment and weather condition effects	A/E	8
ignoring variation in soil conditions	A/E	9
Insufficient site supervision	Contractor	10
Insufficient reinforcement cover	Contractor	11
Selection of material which is unsuitable for the existing climatic conditions	A/E	12
Inadequate concrete cover on the reinforcement	A/E	13
Lack of details	A/E	14
Designer ignorance of material properties	A/E	15

A study by Al-Musaid (1990), determining the influence of owner involvement on certain tasks during construction on project quality, suggests that the A/E, as the representative of the owner, should solve tasks requiring owner input by bringing them to the owner's notice and/or striving to determine the owner's input so as to improve the project quality.

All these researches recognized the importance of the design professional or the A/E organization in ensuring the quality of the project. Thus this research intends to determine directly the QM activities used in the design process of the A/E organizations to determine the quality of service provided by these organizations.

2. 5 DESIGN QUALITY MANAGEMENT AREAS

During literature review fifteen Quality Management Areas were identified, by the author, as having a bearing on the quality of service provided by A/E consulting organizations.

The following sections introduce the reader to these fifteen quality management areas, so as to understand their role in ensuring the organizational service quality of A/E consulting organizations. The fifteen quality management areas are as follows:

1. Organizational Quality Policy
2. Designer Qualification
3. Employee Training and Education
4. Design Planning
5. Design Inputs
6. Design Process
7. Interface Control
8. Design Review
9. Design Changes
10. Subcontractor Control
11. Document Control
12. Design Maintainability
13. Computer Usage
14. Working Relationship
15. Performance Quality Audit

2. 5 .1 Organizational Quality Policy

This area addresses the organizational policy towards establishment of a quality programme and definition of organizational objectives and individual responsibilities. The establishment of a quality programme in an organization communicates the importance given by the organization for ensuring quality of its service. The defining of organizational objectives and individual responsibilities outlines the details of how the organization intends to proceed towards achieving a high standard of service.

This area also covers the presence and the updating process of the quality manual. The quality manual contains information regarding the organizational objectives, quality policy statement, extent of application of the quality management programme documents, organizational objectives and

responsibilities. Organizational procedures regarding quality are also addressed in the quality manual and it is openly available to the employees (McLaughlin 1995). As part of its organizational policy the organization also needs to specify the methodology it intends to follow to achieve quality in its service.

2. 5 .2 Designer Qualification

For an A/E consulting organization the design professional is the essence of its being. This quality management area covers the organizations hiring practices and working guidelines with respect to its design professionals.

2. 5 .3 Employee Training and Education

This quality management area is the one of the most widely recognized quality area by quality experts. Employees should be given on the job training, provided with facilities to improve their general skills, and provided with courses to enable them to handle special tasks.

2. 5 .4 Design Planning

This area covers the A/E consulting organization's process with regards to how it ensures the planning of its design process, and identification of inputs and interfaces. An example of a design plan is shown in Figure 2.1.

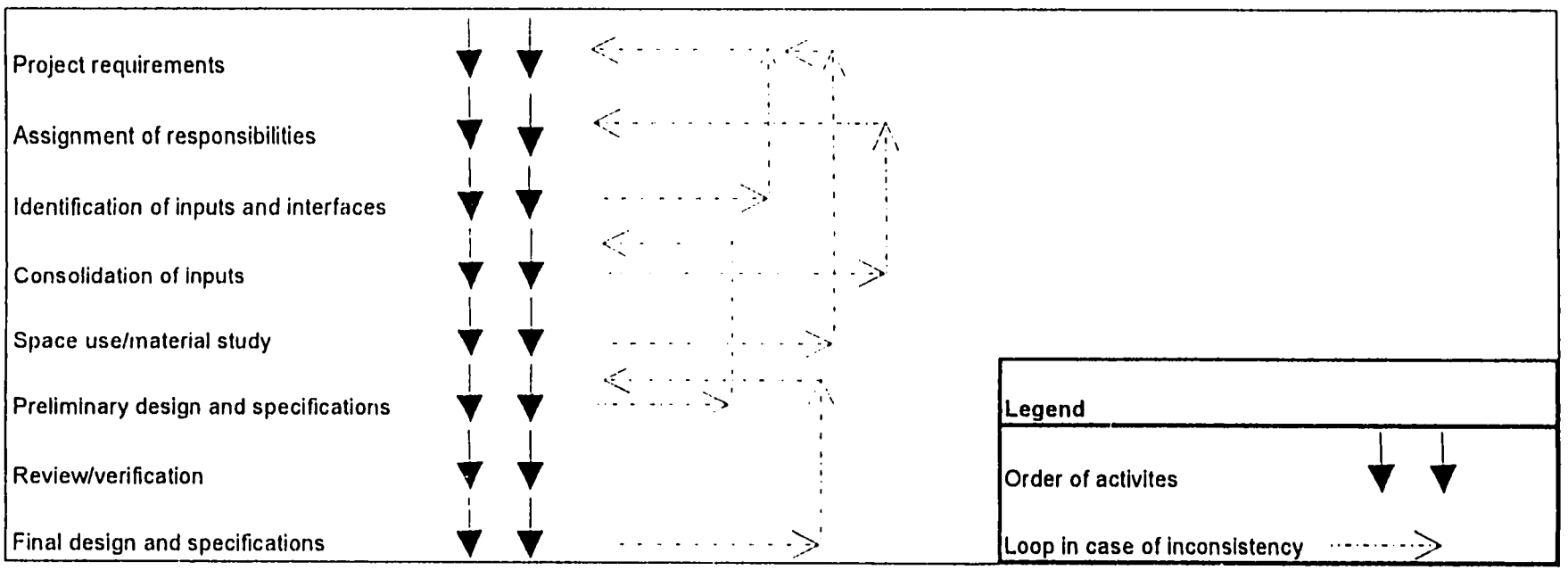


Figure 2.1 Example of a Design Plan

The project design plan is usually in the form of a flow chart identifying the various activities required to deliver the project to the client. The design plan identifies the relationships among the various activities promoting the completion of the project, and notes the responsibilities and assignments with regards to each activity. (ASCE 1990).

2. 5 .5 Design Inputs

This area covers the organizational policy in the identification, transmission, and agreeing upon of design inputs. Design inputs include codes/standards, project functions, design criteria, technical data (and their sources), and drawing arrangement and layout (Motor Columbus et al 1984; Peach 1997).

2. 5 .6 Design Process

This quality management area covers general practices followed by the organization in ensuring quality in the design process.

Factors like assignment of project to a single team, efficiency of preliminary design, design procedures, investigation documents, and

specification of special treatments (Cornick 1991; Motor Columbus et al 1984) are intended to be measured in this quality management area.

2. 5 .7 Interface Control

This quality management area covers aspects of how the organizational procedures ensure the integration of work done by different entities, both internal and external. The transmission of information, the how and when, is also covered in this quality management area.

2. 5 .8 Design Review

The most effective means of identifying deficiencies and incorporating improvements into the construction documents is the establishment of a design review program (Kirby et al 1988). Design reviews are conducted in addition to the ongoing checking process required by design professionals in the course of their work. The design review is an internal quality control process carried out by members of the design team and/or by employees selected for their expertise (ASCE 1990).

Such reviews are undertaken by the organization for detection and correction of errors, and omissions, technical deficiencies. These measures are

undertaken by the organization as way of increasing the quality of its services and limiting exposure to liabilities (Kirby et al 1988).

2. 5 .9 Design Changes

Design changes are an inevitable part of any construction project. Change of circumstances, equipment becoming obsolete, emergence of a better method of doing work, client changing his/her mind, and other varied reasons may account for design changes. Whatever reasons for change, it is vital that the proper procedures for managing design changes should be followed, so that only the correct design documents are used for the project.

2. 5 .10 Subcontractor Control

Lack of expertise, or the client's insistence may prompt the design organization to subcontract part of their work. The well known principles of supplier control in other industries need to be modified to be applied in this case.

Subcontracted design professionals should be informed of the organization's quality programme and monitored to ensure that their work dove-tails with the main project work.

2. 5 .11 Document Control

A quality conscious organization has a sound policy regarding the storage, filing, and transmission of documents. Any construction activity involves specifications, regulations, changes, checks, revisions, and the like, all these bring into being their own respective documents that need to be regularly updated to ensure work is conducted through out the project with the same and latest information. This quality management area is widely recognized as a major factor in increasing organizational efficiency (ASCE 1990).

2. 5 .12 Design Maintainability

This quality management area involves principles from material selection and space allocation. An A/E consulting organization need to ensure that materials specified by it can be easily maintained/replaced by the client. Proper allocation of space needs to provisioned to provide for easy accessibility in any future maintenance works.

Assaf et al (1996) revealed that owner's ranked 'design defects in maintenance practicality and adequacy' as number one in terms of severity. Thus the proper practice of this quality management area assumes a role in determining the service quality of the A/E consulting organizations.

2. 5 .13 Computer Usage

Computers have nowadays become an integral part of any organization. The proper use of computers can lead to a decrease in the amount of doing work/rework, thus increasing the productivity of the organization. The increasing availability of design related softwares also increase the responsibility of the organization for proper selection.

2. 5 .14 Working Relationship

The proper working relationship of an organization takes into account the co-operation with and the satisfaction of its customers. The reason behind naming this quality management area 'Working Relationship' and not 'Customer Satisfaction' is the posing of the question by some as to who is the real customer· the project owner or the project user (Turner 1993).

A customer can also be defined as any entity that in some way derives some benefit from the project. In increasing order of receiving benefit, from the work of the A/E consulting organization, customers can be enumerated as society, project users, maintenance contractors, construction contractors, and project owners. This study measures, in this quality management area, the relationship of the design organization only with those entities that it comes into direct contact with, i.e., the project owner, and to a lesser extent the construction

contractor. This quality management area covers the A/E organization's interaction with the client and the construction contractor in working out ways to improve the quality of the project.

2. 5 .15 Performance Quality Audit

Auditing can be defined as a methodical study and review of one or more quality practices, and the checking for compliance and effectiveness; for the purpose of verification and improvement (Hutchins 1993; Mirams and McElheron 1995). This quality management area assesses the A/E consulting organizations process in auditing its quality performance by self examination and customer feedback.

CHAPTER 3

RESEARCH METHODOLOGY

3. 1 GENERAL

The research, being of the exploratory type, will consist of a questionnaire survey among the local A/E organizations of the Eastern Province. The questionnaire (Appendix I) is designed to evaluate the prevalence of the outlined QM activities among the A/E organizations. The questionnaire survey will be conducted mostly by mailing the questionnaire and partly by the conducting an interview with willing organizations. This method while obviously providing the information regarding the prevalence of QM activities among the A/E organizations will also provide more details for assessing the reasons for the presence/lack of these QM activities among the A/Es.

3. 2 QUESTTIONAIRE DESIGN

The questionnaire (Appendix I) consists of seventy questions grouped into the following QM areas as shown in Table 3.1.

Table 3.1. Questionnaire Division Into Design Quality Management Areas

S. No.	Quality Management Areas	Question Numbers
1	Organizational Quality Policy	1-4
2	Designer Qualification	5-6
3	Employee Training and Education	7-9
4	Design Planning	10-12
5	Design Inputs	13-14
6	Design Process	15-20
7	Interface Control	21-24
8	Design Review	25-32
9	Design Changes	33-35
10	Subcontractor Control	36-37
11	Document Control	38-41
12	Design Maintainability	42-43
13	Computer Usage	44-45
14	Working Relationship	46-66
15	Performance Quality Audit	67-70

The questions inquire about the extent of practice of the QM practices, in the above areas, in the A/E consulting organization. The respondents are requested to record their opinion regarding the extent of these QM practices as 'Always, 'Mostly', 'Sometimes', 'Rarely', and 'Never'. The responses will be quantified as follows:

- 'Always' equal to one hundred percent
- 'Mostly' equal to seventy five percent
- 'Sometimes' equal to fifty percent
- 'Rarely' equal to twenty five percent
- 'Never' equal to zero percent.

The respondents answers will be utilized to fulfill the objectives of this study. The average prevalence of quality management practices will be determined by the following equation:

Average Prevalency = $100x_1 + 75x_2 + 50x_3 + 25x_4 + 0x_5) / (x_1 + x_2 + x_3 + x_4 + x_5)$

where

x_1 = number of respondents answering 'Always'

x_2 = number of respondents answering 'Mostly'

x_3 = number of respondents answering 'Sometimes'

x_4 = number of respondents answering 'Rarely'

x_5 = number of respondents answering 'Never'.

3.3 SAMPLE SIZE

As per the research scope, the study is limited to the A/E offices in the Eastern Province. The sample size will be determined by the use of the following equations (Kish 1995):

$$n_0 = pq / V^2 \qquad \text{(Equation 1)}$$

$$n = n_0 / [1 + (n_0 / N)] \qquad \text{(Equation 2)}$$

where

n_0 is the first estimate of the sample size,

p is the proportion of the characteristic being measured in the target population ,

q is equal to 1- p

V is the maximum percentage of standard error allowed,

N is the population size,

n is the sample size.

For the purposes of getting the maximum sample size the values of 'p' and 'q' are taken as p = 0.5 and q = 0.5 respectively. The total population of this study consists of one hundred and forty consulting offices (Appendix 2) giving a value of N=140. As the responses to this study are given in a qualitative manner, which leads to a certain lower accuracy than a quantitative response, the maximum standard error allowed in this study was chosen as V = 10% (0.1). Thus taking the above values of p = 0.5, q = 0.5, V = 0.1, and N = 140 we get the following values for 'n_0' and 'n':

$n_0 = 25$, and

$n = 21.21 \cong 22$

Questionnaires were sent to all the one hundred and forty (140) consulting organizations. Of this whole population four organizations officially declined to participate and twenty-five organizations participated in the survey. This gives this survey a response rate of about twenty one percent (21%). The response of twenty-five organizations also lessens the maximum standard error of this survey to about $V = 9.15\%$.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter discusses the results and analysis of the survey on the prevalent quality management practices (QMPs) in the local construction industry. The fifteen quality management areas (QMA) are analysed first, and then an analysis of the prevalency and importance given to these quality management areas is undertaken. A method for evaluating the service quality of the design organization is also be introduced in this chapter.

4.1 QUALITY MANAGEMENT AREAS (QMAs)

As mentioned before the statements in the questionnaire were designed to measure the fifteen quality management areas mentioned in Table 3.1. The percentage frequency of responses to the seventy statements measuring the different quality management practices is given in Table 4.1. The following sections undertake a detailed discussion of the fifteen Quality Management Areas (QMA) and their comprising Quality Management Practices (QMP).

TABLE 4.1 Percentage Response Frequency of Quality Management Practices

S. No.	Always	Mostly	Some-times	Rarely	Never	No Response	QMP Prevalence
QMP1	64.00	24.00	8.00	0.00	4.00	0.00	86.00
QMP2	64.00	32.00	0.00	0.00	4.00	0.00	88.00
QMP3	48.00	24.00	16.00	4.00	4.00	4.00	75.00
QMP4	60.00	20.00	8.00	0.00	12.00	0.00	79.00
QMP5	68.00	24.00	8.00	0.00	0.00	0.00	90.00
QMP6	32.00	36.00	24.00	4.00	4.00	0.00	72.00
QMP7	28.00	28.00	36.00	4.00	4.00	0.00	68.00
QMP8	12.00	20.00	64.00	4.00	0.00	0.00	60.00
QMP9	52.00	28.00	16.00	4.00	0.00	0.00	82.00
QMP10	60.00	32.00	8.00	0.00	0.00	0.00	88.00
QMP11	48.00	40.00	12.00	0.00	0.00	0.00	84.00
QMP12	44.00	36.00	12.00	4.00	0.00	4.00	78.00
QMP13	32.00	60.00	4.00	4.00	0.00	0.00	80.00
QMP14	40.00	48.00	8.00	4.00	0.00	0.00	81.00
QMP15	24.00	52.00	20.00	0.00	0.00	4.00	73.00
QMP16	24.00	64.00	8.00	0.00	0.00	4.00	76.00
QMP17	44.00	44.00	8.00	0.00	0.00	4.00	81.00
QMP18	64.00	28.00	8.00	0.00	0.00	0.00	89.00

TABLE 4.1 Percentage Response Frequency of Quality Management Practices (cont.)

QMP	Always	Mostly	Some-times	Rarely	Never	No Response	QMP Prevalence
QMP19	64.00	20.00	16.00	0.00	0.00	0.00	87.00
QMP20	36.00	28.00	28.00	0.00	4.00	4.00	71.00
QMP21	20.00	56.00	12.00	0.00	4.00	8.00	68.00
QMP22	40.00	48.00	8.00	0.00	4.00	0.00	80.00
QMP23	36.00	44.00	16.00	0.00	4.00	0.00	77.00
QMP24	16.00	56.00	20.00	0.00	4.00	4.00	68.00
QMP25	52.00	40.00	4.00	4.00	0.00	0.00	85.00
QMP26	72.00	20.00	8.00	0.00	0.00	0.00	91.00
QMP27	72.00	20.00	4.00	4.00	0.00	0.00	90.00
QMP28	76.00	20.00	4.00	0.00	0.00	0.00	93.00
QMP29	76.00	24.00	0.00	0.00	0.00	0.00	94.00
QMP30	64.00	28.00	4.00	4.00	0.00	0.00	88.00
QMP31	44.00	40.00	12.00	0.00	0.00	4.00	80.00
QMP32	76.00	20.00	0.00	0.00	0.00	4.00	91.00
QMP33	72.00	24.00	0.00	4.00	0.00	0.00	91.00
QMP34	60.00	32.00	4.00	0.00	0.00	4.00	86.00
QMP35	72.00	16.00	0.00	4.00	0.00	8.00	85.00
QMP36	52.00	32.00	8.00	0.00	4.00	4.00	80.00

TABLE 4.1 Percentage Response Frequency of Quality Management Practices (cont.)

QMP	Always	Mostly	Some-times	Rarely	Never	No Response	QMP Prevalence
QMP37	72.00	12.00	4.00	4.00	4.00	4.00	84.00
QMP38	80.00	12.00	4.00	0.00	0.00	4.00	91.00
QMP39	60.00	32.00	4.00	0.00	0.00	4.00	86.00
QMP40	64.00	32.00	0.00	0.00	0.00	4.00	88.00
QMP41	60.00	20.00	12.00	0.00	0.00	8.00	81.00
QMP42	52.00	28.00	16.00	0.00	0.00	4.00	81.00
QMP43	48.00	36.00	16.00	0.00	0.00	0.00	83.00
QMP44	52.00	24.00	16.00	0.00	4.00	4.00	78.00
QMP45	56.00	24.00	16.00	0.00	4.00	0.00	82.00
QMP46	40.00	32.00	12.00	12.00	0.00	4.00	73.00
QMP47	36.00	36.00	12.00	12.00	0.00	4.00	72.00
QMP48	60.00	24.00	12.00	0.00	0.00	4.00	84.00
QMP49	64.00	28.00	4.00	0.00	0.00	4.00	87.00
QMP50	68.00	24.00	4.00	0.00	0.00	4.00	88.00
QMP51	28.00	36.00	20.00	0.00	8.00	8.00	65.00
QMP52	52.00	28.00	8.00	8.00	0.00	4.00	79.00
QMP53	44.00	44.00	8.00	0.00	0.00	4.00	81.00
QMP54	44.00	28.00	8.00	8.00	4.00	8.00	71.00

TABLE 4.1 Percentage Response Frequency of Quality Management Practices (cont.)

QMP	Always	Mostly	Some-times	Rarely	Never	No Response	QMP Prevalence
QMP55	16.00	48.00	20.00	8.00	4.00	4.00	64.00
QMP56	56.00	16.00	20.00	4.00	0.00	4.00	79.00
QMP57	24.00	36.00	28.00	4.00	4.00	4.00	66.00
QMP58	24.00	24.00	40.00	4.00	0.00	8.00	63.00
QMP59	24.00	20.00	44.00	4.00	4.00	4.00	62.00
QMP60	32.00	16.00	32.00	8.00	8.00	4.00	62.00
QMP61	24.00	36.00	28.00	4.00	0.00	8.00	66.00
QMP62	32.00	16.00	36.00	0.00	4.00	12.00	62.00
QMP63	44.00	20.00	28.00	4.00	0.00	4.00	74.00
QMP64	44.00	28.00	24.00	0.00	0.00	4.00	77.00
QMP65	36.00	24.00	28.00	0.00	4.00	8.00	68.00
QMP66	48.00	12.00	28.00	4.00	4.00	4.00	72.00
QMP67	48.00	44.00	4.00	0.00	4.00	0.00	83.00
QMP68	32.00	16.00	36.00	8.00	8.00	0.00	64.00
QMP69	16.00	20.00	44.00	8.00	12.00	0.00	55.00
QMP70	8.00	24.00	44.00	12.00	12.00	0.00	51.00

4. 1 .1 Organizational Quality Policy

An organization shows its interest in quality through its quality policy. As part of its quality policy an organization must establish a quality programme, define organizational objectives and individual responsibilities. The organization must also outline a specified methodology for how its services are to be provided. A quality manual provides the organization with the details of what and how a thing is to be done and by whom.

The Organizational Quality Policy was measured through the following four statements, QMP1-QMP4:

- QMP1 - The organization has an established quality programme.
- QMP2 - Organizational objectives and individual responsibilities for quality are clearly defined.
- QMP3 - Quality manual is present and is updated to reflect current quality policies and procedures.
- QMP4 - The organization has a specified design methodology.

The average prevelancy of the stated Quality Management Practices (QMP) and the response statistics of these statements are given in Figure 4.1 and Table 4.2 respectively.

The statement measuring the defining of organizational objectives and defining of individual responsibilities (QMP2) was the most prevalent in this

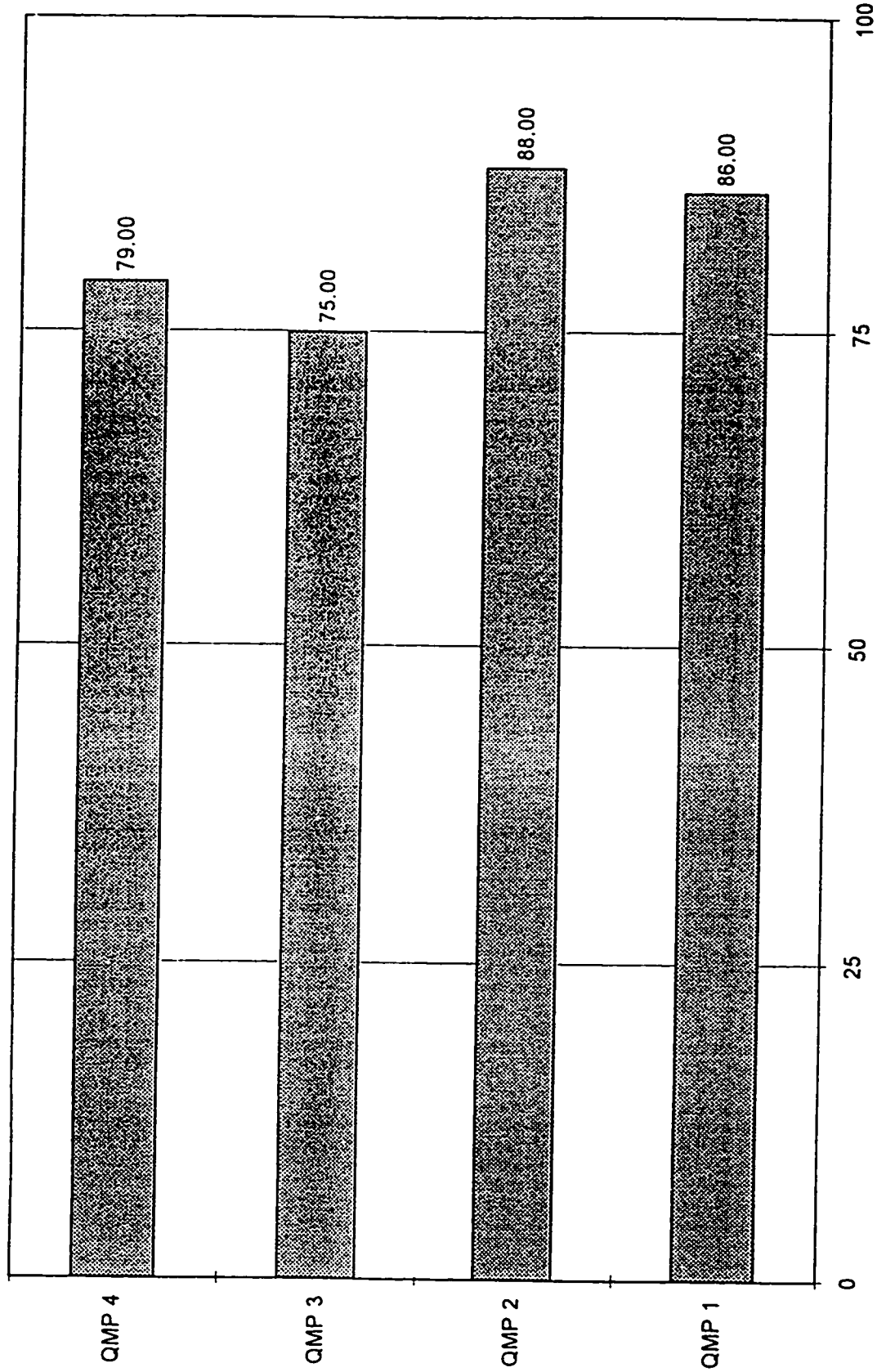


Figure 4.1 QMP Distribution for Organizational Quality Policy

TABLE 4.2 RESPONSE STATISTICS ORGANIZARIONAL QUALITY POLICY (QMA1)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 1	The organization has an established quality programme.	86.00	0.00	100.00	100.00	24.02	2	17
QMP 2	Organizational objectives and individual responsibilities for quality are clearly defined.	88.00	0.00	100.00	100.00	21.79	1	10
QMP 3	Quality manual is present and is updated to reflect current quality policies and procedures.	75.00	0.00	100.00	100.00	31.46	4	46
QMP 4	The organization has a specified design methodology.	79.00	0.00	100.00	100.00	33.60	3	38

quality management area followed by the establishment of a quality programme (QMP1).

The statement measuring the prevelancy of a specified design methodology (QMP4) has a somewhat lower prevelancy than the above two statements due to what some respondents revealed to the author as possible difficulties in getting the employees to follow a specific methodology. This could be explained by the fact that most of the organizations have a multinational workforce which already has some years of experience behind them before joining that particular organization. The work-force's previous experience causes some conflict in following the specified methodology as they may feel comfortable in working the way they have been before joining that particular organization. But there is a recognition of benefits in following a specified design methodology by the respondents and the prevelancy of this quality management practice may increase in the future.

The statement regarding the quality manual and its updating (QMP3) scored the lowest in this quality management area highlighting a slight need for improvement. Overall the quality management area measuring organizational quality policy revealed a good effort by the organization in their service.

4. 1 .2 Designer Qualification

Designer qualification was measured through the following two statements QMP5 and QMP6:

- QMP5 - All design professionals in the organization are qualified and the organization keeps a record of their qualifications.
- QMP6 - All the design professionals in the organization follow a single design method/code.

Their average prevelancy and response statistics are shown in Figure 4.2 and Table 4.3 respectively.

The reputation of a design organization is based on the design professionals it employs. Thus it is no surprise that a design organization ensures that the design professionals it hires are highly qualified, and the measuring statement (QMP5) has a very high prevalency rate.

On the other hand the statement measuring the following of a single design methodology (QMP6) has comparatively lower prevelancy. The reason for the lower prevelancy of QMP6 can be cited to the fact that there is no building code in Saudi Arabia, and most of the design staff comprises of individuals from different countries who tend to follow the design methods/codes of their local countries. The design organizations tend not to do much about this quality management practice due to the following reasons:

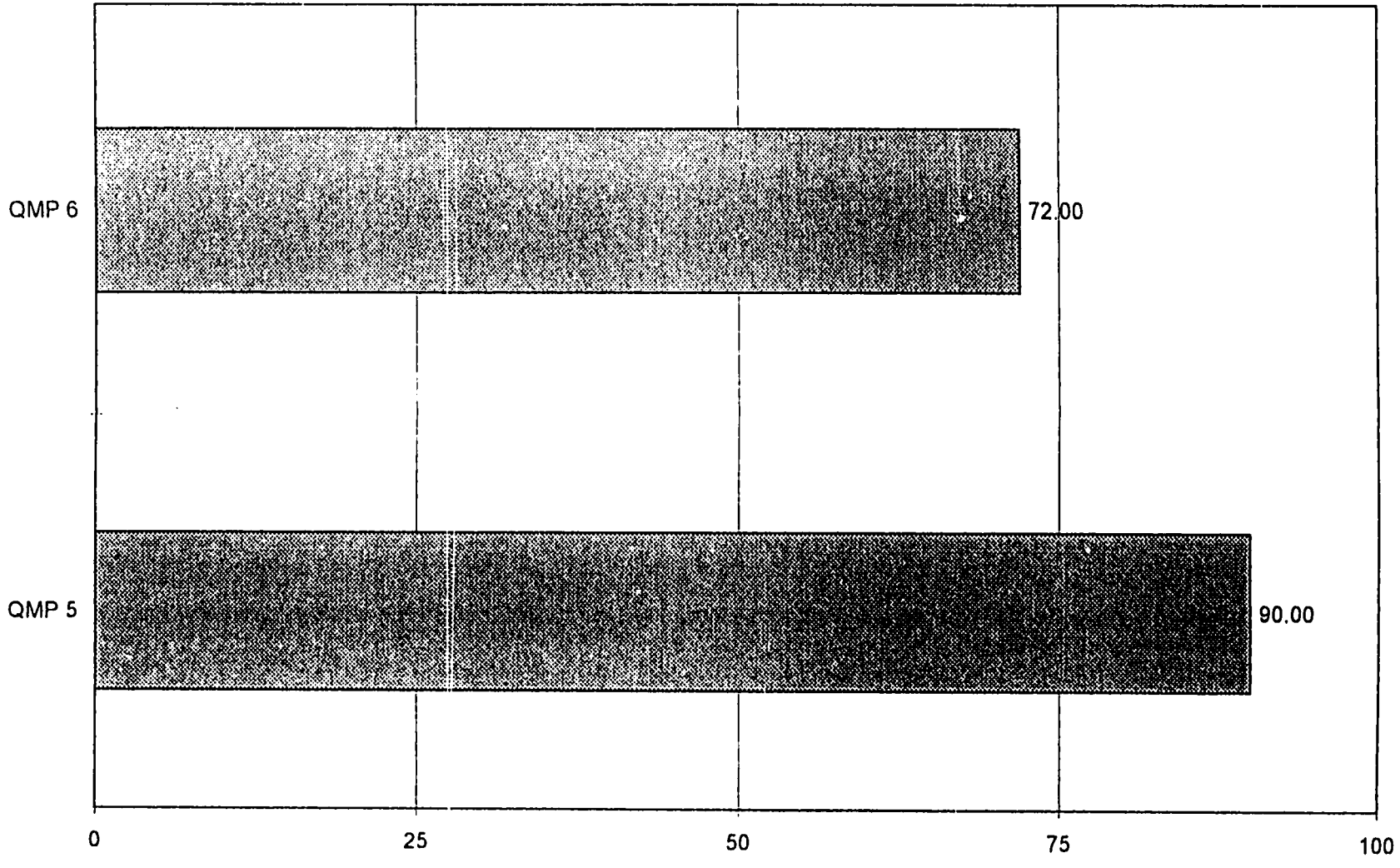


Figure 4.2 QMP Distribution of Designer Qualification

TABLE 4.3 RESPONSE STATISTICS FOR DESIGNER QUALIFICATION (QMA2)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 5	All design professionals in the organization are qualified and the organization keeps a record of their qualifications.	90.00	50.00	100.00	100.00	16.14	1	7
QMP 6	All the design professionals in the organization follow a single design method/code.	72.00	0.00	100.00	75.00	26.34	2	50

- design organizations are satisfied with the service of their design professionals
- fear of becoming dependent upon design professionals from one country
- impracticality due to high cost and time in training employees to follow a single design method.

4. 1 .3 Employee Training and Education

The following statements (QMP7-QMP9) measure employee training and education:

- QMP7 - Employees are provided with on the job training.
- QMP8 - Short courses and seminars for employees are provided.
- QMP9 - The organization provides office library facilities.

The average prevelancy and response statistics for this quality management area are given in Figure 4.3 and Table 4.4 respectively.

While office library facilities (QMP9) are usually provided to the employees there is significant drop in prevelancy rate for the other two quality management practices in this quality management area. The low prevelancy rates for QMP7 and QMP8 can be explained by the following.

- usually qualified employees are hired thus there is not much need for providing on job training

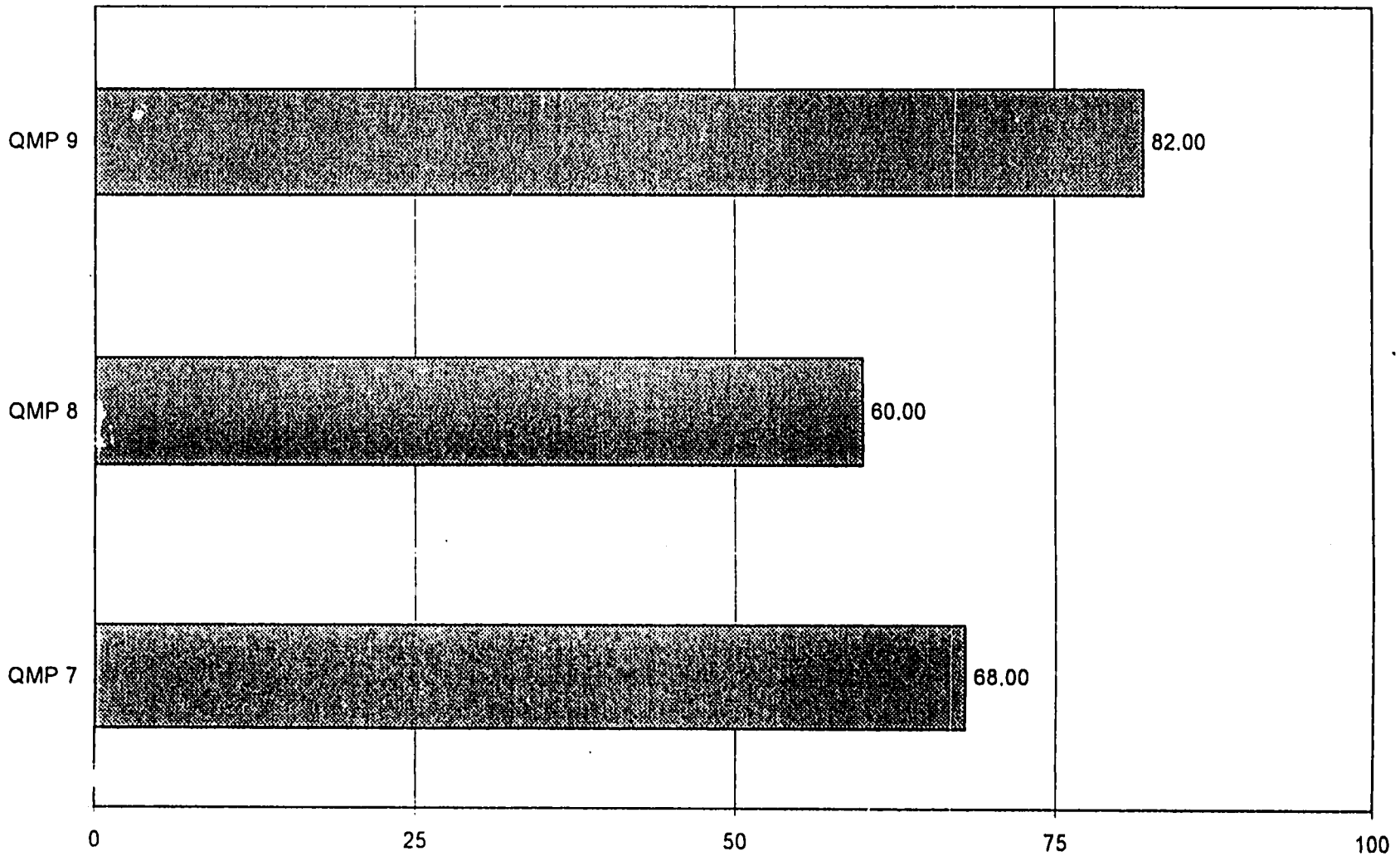


Figure 4.3 QMP Distribution for Employee Training and Education

TABLE 4.4 RESPONSE STATISTICS FOR EMPLOYEE TRAINING AND EDUCATION (QMA3)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 7	Employees are provided with on the job training.	68.00	0.00	100.00	50.00	26.54	2	55
QMP 8	Short courses and seminars for employees are provided.	60.00	25.00	100.00	50.00	19.09	3	68
QMP 9	The organization provides office library facilities.	82.00	25.00	100.00	100.00	22.27	1	27

- training is usually limited to showing the ropes to new employees during their initial probation period
- short courses are provided only when there is an urgent need of a certain specialization
- short term and long term needs play a major role in deciding whether to provide training courses or hire a new specialist.

These quality management practices need to be increased by the A/E consulting organization to cope up with the future demands of Saudization. The training of the local workforce not only benefits the country, but also benefits the organization by making it less dependent on outside workforce.

4. 1 .4 Design Planning

This quality management area was measured by the following three statements, QMP10-QMP12, whose average prevelancy and response statistics are shown in Figure 4.4 and Table 4.5 respectively:

- QMP10 - The design process is planned.
- QMP11 - Design inputs are elaborated before preparation of design documents.
- QMP12 - Design interfaces are identified in the preliminary design.

Planning the design process (QMP10) ensures that plan drawings and reviews are conducted in a logical manner. While elaborating the design inputs

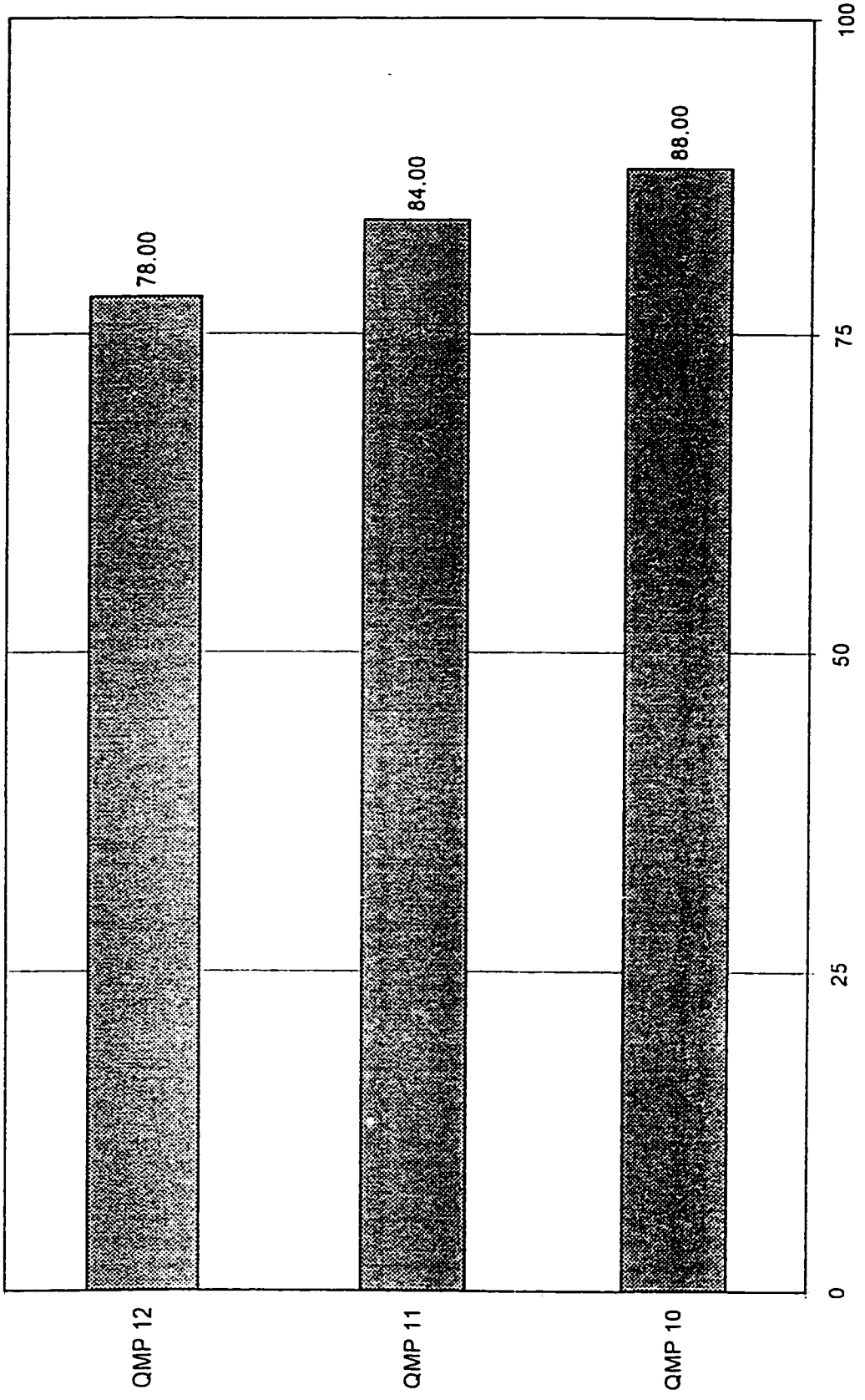


Figure 4.4 QMP Distribution of Design Planning

TABLE 4.5 RESPONSE STATISTICS FOR DESIGN PLANNING (QMA4)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 10	The design process is planned.	88.00	50.00	100.00	100.00	16.33	1	10
QMP 11	Design inputs are elaborated before preparation of design documents.	84.00	50.00	100.00	100.00	17.50	2	22
QMP 12	Design interfaces are identified in the preliminary design.	78.00	25.00	100.00	100.00	26.34	3	41

(QMP11) required ensures that all the required information is made available for that work to start and progress smoothly. These quality management practices as seen from Figure 4.4 are usually practised.

It is not unusual in the construction industry to have one part of work done by one entity and the other by an other entity. Even in a single organization work on different parts of the project may be undertaken by different departments/teams. Thus the identification of design interfaces in the preliminary design (QMP12) can lead to smoother work by defining authorities and responsibilities clearly early on in the project. This quality management practice needs to be undertaken more often.

4. 1 .5 Design Inputs

Design inputs was measured by the following two statements QMP13 and QMP14:

- QMP13 - Design inputs are identified and transmitted in written form, thus defining responsibility.
- QMP14 - Design inputs are reviewed and agreed upon by the interfacing division early on in the design process.

The average prevelancy and response statistics of this quality management area are given in Figure 4.5 and Table 4.6 respectively.

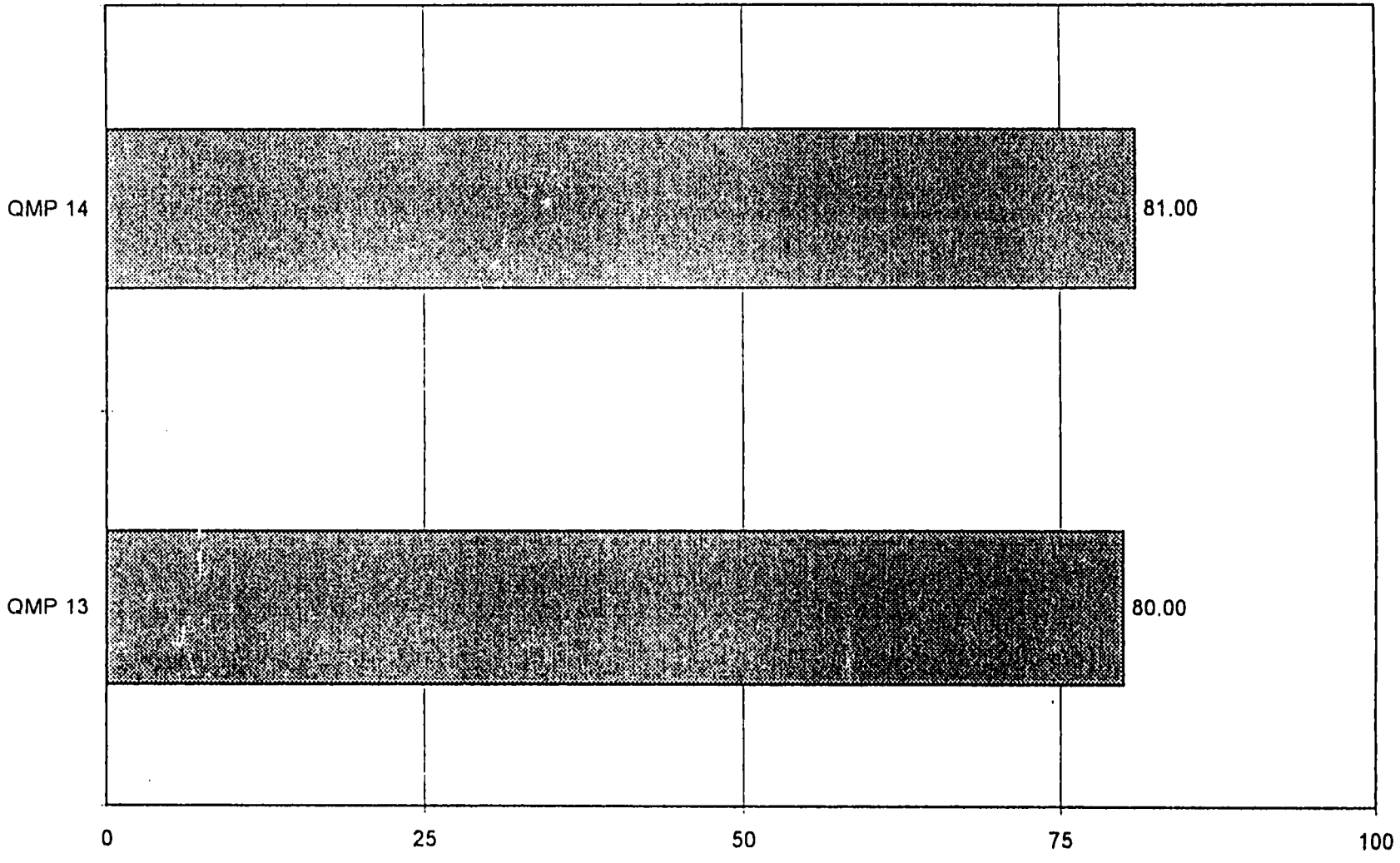


Figure 4.5 QMP Distribution for Design Inputs

TABLE 4.6 RESPONSE STATISTICS FOR DESIGN INPUTS (QMA5)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 13	Design inputs are identified and transmitted in written form, thus defining responsibility.	80.00	25.00	100.00	75.00	17.68	2	34
QMP 14	Design inputs are reviewed and agreed upon by the interfacing division early on in the design process.	81.00	25.00	100.00	75.00	19.47	1	29

Identifying and transmitting design inputs in written form (QMP13) while being a good quality management practice, ensures making sure of its accuracy by those taking responsibility and making it easier to trace the source of any possible deviations. The reviewing and agreeing upon of design inputs by the interfacing divisions (QMP14) not only increases the accuracy of the inputs by their cross-verification but also plays a role in ensuring the unity of design. An increase in the prevelancy of this quality management will aid in the enhancing the service provided by the design organization.

4. 1 .6 Design Process

The following six statements, QMP15-QMP20, measured this quality management area:

- QMP15 - Work on a project is assigned to a single team.
- QMP16 - The preliminary design resolves all discrepancies related to structural and equipment interaction.
- QMP17 - The preliminary design allows for selection of major dimensions of the structures.
- QMP18 - Design activities (calculations, drawings, specifications, and others) are performed according to established procedures or standard templates.

- QMP19 - Documentation of investigations, assumptions, and computer calculations utilized for design activities is kept.
- QMP20 - Design documents specify important construction methods and data (special treatments, sequence of operations, applicable specifications, special equipment, and work methods).

Their average prevelancy and response statistics are shown in Figure 4.6 and Table 4.7 respectively.

Work on a project being assigned to a single team (QMP15) encourages the quick transmission of data and allows the minimization of delay, as members keep each other informed on any problems being faced by them and any changes required in the work and their consequences on their or other's work. Even if it is impractical to make all the design professionals, assigned on a large project, work in a single team, representatives from different divisions could form a team in an effort to increase the quality of their service. This QMP needs to be practised more often.

The preliminary design should take into consideration all discrepancies related to structure and equipment interaction, and important construction methods should be specified in the design documents (QMP16 and QMP20 respectively). The belief by the design professionals that contractors may transfer responsibility upon the design organization, by explaining that this

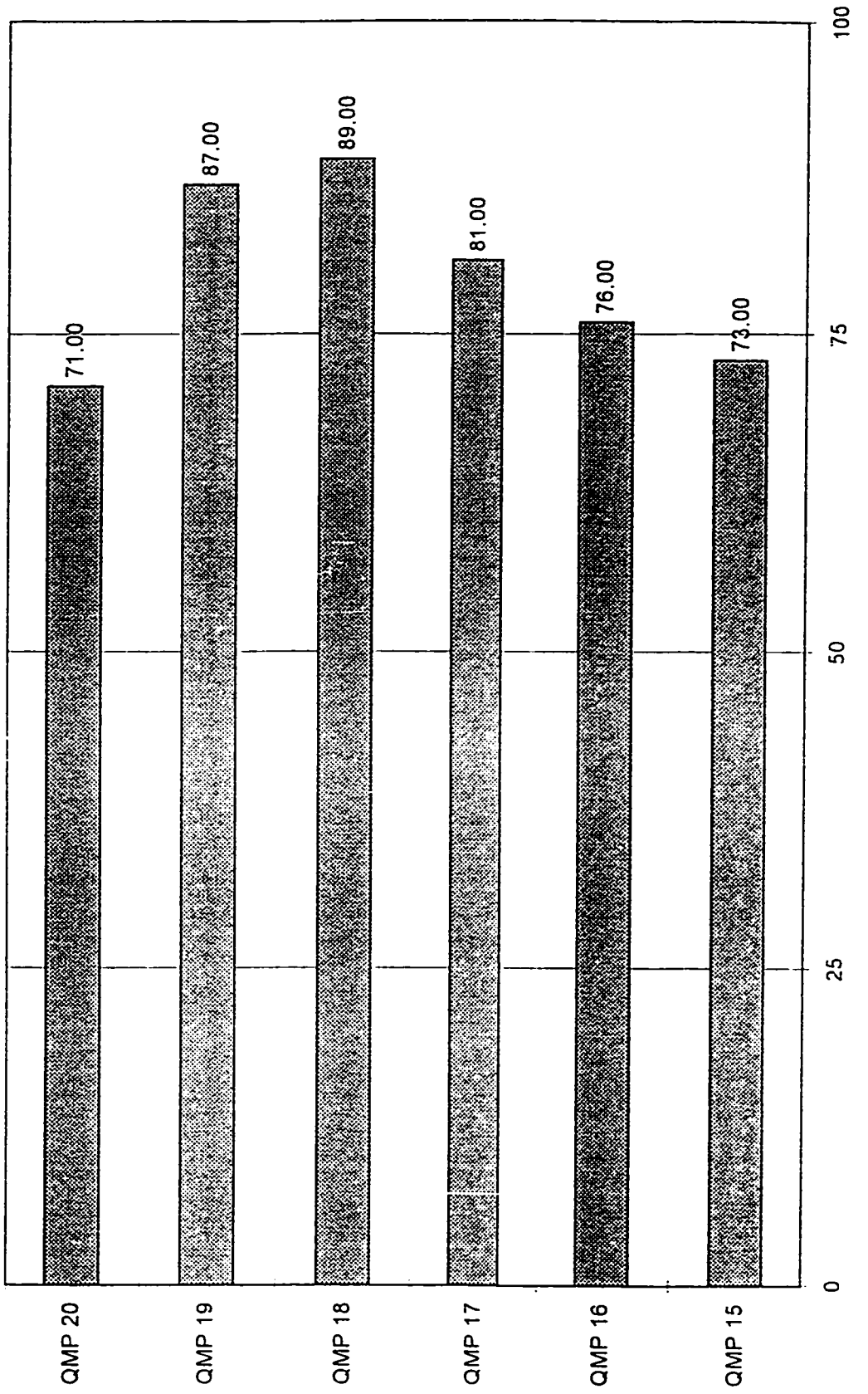


Figure 4.6 QMP Distribution for Design Process

TABLE 4.7 RESPONSE STATISTICS FOR DESIGN PROCESS (QMA6)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 15	Work on a project is assigned to a single team.	73.00	50.00	100.00	75.00	22.73	5	48
QMP 16	The preliminary design resolves all discrepancies related to structural and equipment interaction.	76.00	50.00	100.00	75.00	21.02	4	45
QMP 17	The preliminary design allows for selection of major dimensions of the structures.	81.00	50.00	100.00	100.00	23.14	3	29
QMP 18	Design activities (calculations, drawings, specifications, and others) are performed according to established procedures or standard templates.	89.00	50.00	100.00	100.00	16.27	1	9

TABLE 4.7 RESPONSE STATISTICS FOR DESIGN PROCESS (QMA6) (cont.)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 19	Documentation of investigations, assumptions, and computer calculations utilized for design activities is kept.	87.00	50.00	100.00	100.00	19.26	2	15
QMP 20	Design documents specify important construction methods and data (special treatments, sequence of operations, applicable specifications, special equipment, and work methods).	71.00	0.00	100.00	100.00	29.47	6	53

course of action was specified in the design documents, is one of the main reasons for the low prevelancy of these quality management practices.

The other three quality management practices, QMP17-QMP19, of this quality management area are practised satisfactorily.

4. 1 .7 Interface Control

Interface control was measured by the following four statements, QMP21-QMP24:

- QMP21 - Interface control is practiced and any activity affecting the design quality is identified in writing.
- QMP22 - Design information transmitted from one organization to another is documented and identified.
- QMP23 - Transmission of design information between organizations is done through the use of standard procedures or templates.
- QMP24 - Any verbally or informally transmitted information is promptly confirmed in writing.

The average prevelancy and response statistics are given in Figure 4.7 and Table 4.8 respectively.

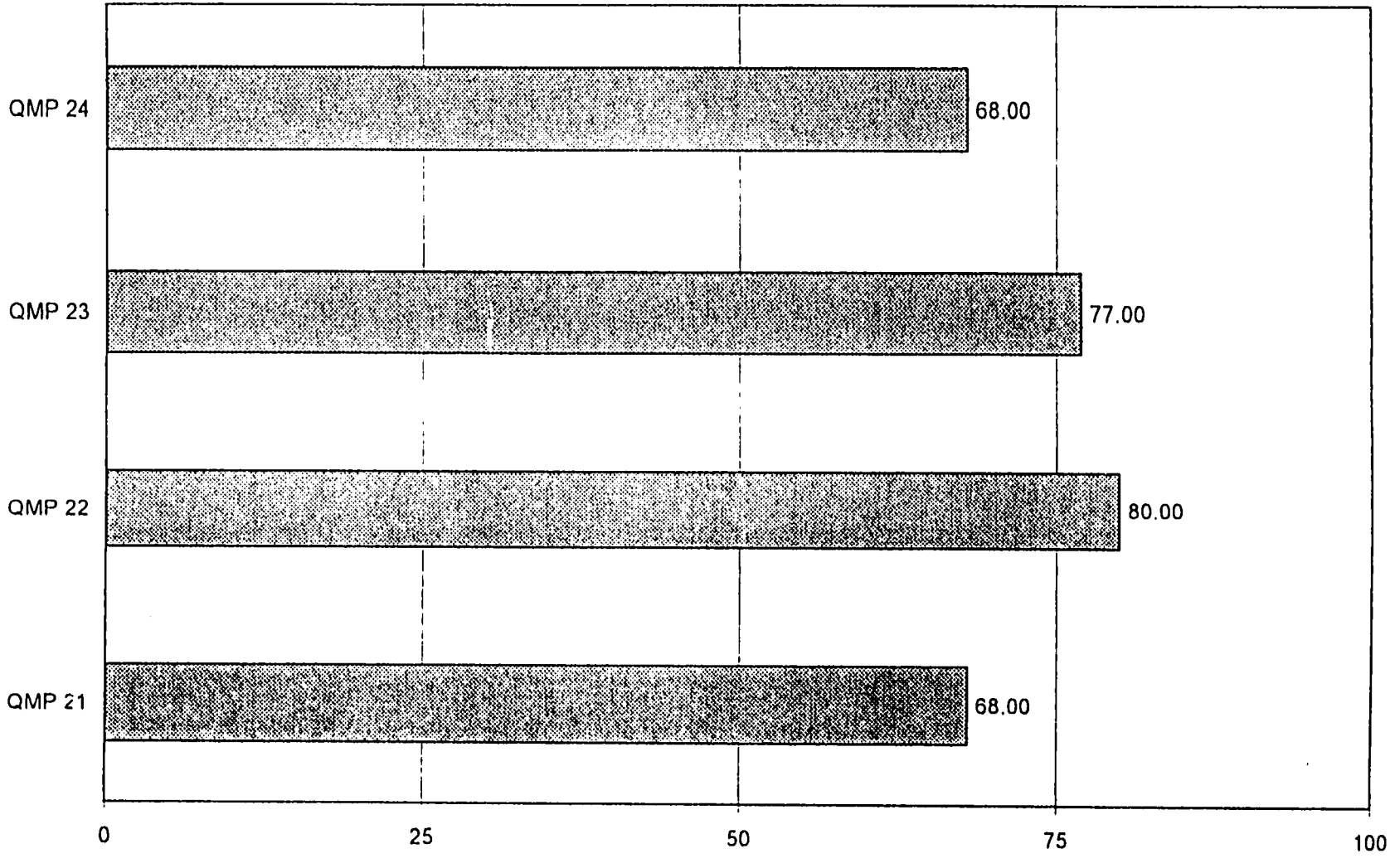


Figure 4.7 QMP Distribution for Interface Control

TABLE 4.8 RESPONSE STATISTICS FOR INTERFACE CONTROL (QMA7)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 21	Interface control is practiced and any activity affecting the design quality is identified in writing.	68.00	0.00	100.00	75.00	29.33	3	55
QMP 22	Design information transmitted from one organization to another is documented and identified.	80.00	0.00	100.00	75.00	22.82	1	34
QMP 23	Transmission of design information between organizations is done through the use of standard procedures or templates.	77.00	0.00	100.00	75.00	23.85	2	43
QMP 24	Any verbally or informally transmitted information is promptly confirmed in writing.	68.00	0.00	100.00	75.00	25.54	3	55

This quality management area needs to be looked into by the design organization and worked upon to increase its prevelancy. Quality management practices measuring the transmission of information between organizations (QMP22 and QMP23) are practised just satisfactorily as this is perceived by the organizations as a way of minimizing disputes and upholding their case in the event of any disagreements. Standard procedures and templates (QMP23) need to be used more often. The use of standard procedures clarifies the protocol to be followed while the use of standard templates ensures that no basic information is left out and also helps in deciding which information is to be given.

Design information also tends to be given to other interfacing organizations only when the party asks for it and the organization feels their request is justified, or when instructed upon by the client. This reluctance in practising this quality management area is reflected in the other two quality management practices (QMP21 and QMP24). The lower prevelancy of this quality management area stresses the need for building more trust and co-operation between the interfacing divisions.

4. 1 .8 Design Review

Design review was measured by the following eight statements, QMP25-QMP32:

- QMP25 - Design review/verifications are made by persons other than those performing the particular design.
- QMP26 - Design calculations are reviewed and verified.
- QMP27 - Review/verification of design drafts and drawings.
- QMP28 - Review/verification of specifications and standards.
- QMP29 - Review/verification of design drawings.
- QMP30 - Review/verification of space allocation and capacity.
- QMP31 - Review/verification of aesthetics.
- QMP32 - Final project drawings and specifications are reviewed and any omissions corrected before being handed over to the construction contractor.

The average prevelancy and response statistics for this quality management area are shown in Figure 4.8 and Table 4.9 respectively.

This area is vital to any organization for ensuring the quality of its design plans and as thus this quality management area has the highest prevelancy rating of the fifteen quality management areas. It is suggested that a higher increase in independent deign reviews (QMP25) and aesthetic review (QMP31) will lead to a complementary increase in the service quality of the organization.

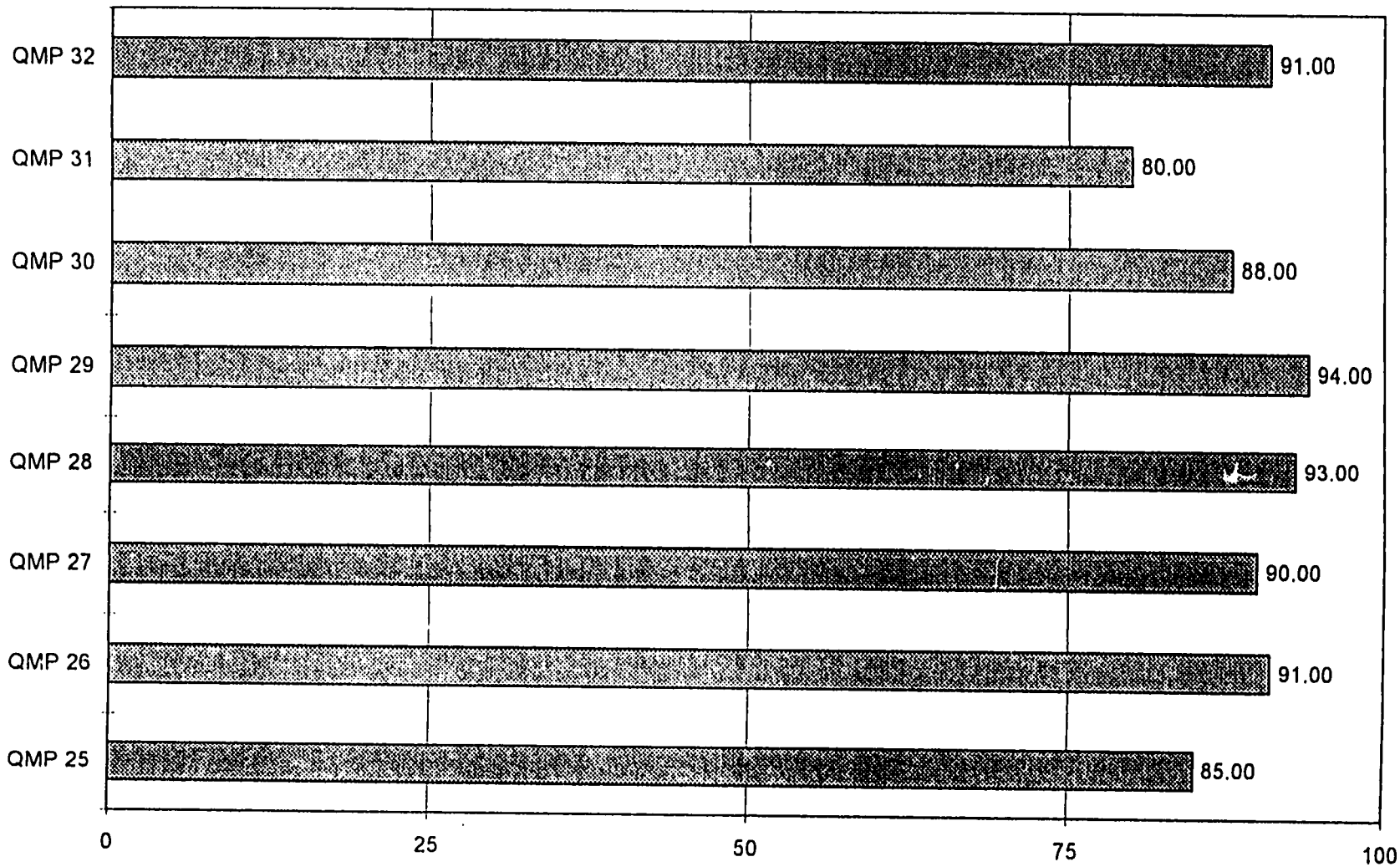


Figure 4.8 QMP Distribution for Design Review

TABLE 4.9 RESPONSE STATISTICS FOR DESIGN REVIEW (QMA8)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 25	Design review/verifications are made by persons other than those performing the particular design.	85.00	25.00	100.00	100.00	19.09	7	20
QMP 26	Design calculations are reviewed and verified.	91.00	50.00	100.00	100.00	15.94	3	3
QMP 27	Review/verification of design drafts and drawings.	90.00	25.00	100.00	100.00	19.09	5	7
QMP 28	Review/verification of specifications and standards.	93.00	50.00	100.00	100.00	13.54	2	2
QMP 29	Review/verification of design drawings.	94.00	75.00	100.00	100.00	10.90	1	1

TABLE 4.9 RESPONSE STATISTICS FOR DESIGN REVIEW (QMA8) (cont.)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 30	Review/verification of space allocation and capacity.	88.00	25.00	100.00	100.00	19.26	6	10
QMP 31	Review/verification of aesthetics.	80.00	50.00	100.00	100.00	23.94	8	34
QMP 32	Final project drawings and specifications are reviewed and any omissions corrected before being handed over to the construction contractor.	91.00	75.00	100.00	100.00	21.51	3	3

4. 1 .9 Design Changes

Design changes are measured through the following three statements, QMP33-QMP35:

- QMP33 - Any design changes affecting contractual requirements are made available in writing, and the client's and/or client's representative's approval obtained.
- QMP34 - Design changes are identified and documented for easy retrieval.
- QMP35 - Activities affected by design changes are identified and the concerned personnel duly notified.

The average prevelancy and response statistics are given in Figure 4.9 and Table 4.10 respectively.

There is a good prevalence of this quality management area, design changes affecting contractual requirements (QMP33) has one of the highest ratings of the total quality management practices surveyed. The reason for such a high prevalence is the need of the design organization to protect itself in case of any possible disputes later on.

4. 1 .10 Subcontractor Control

This quality management area was measured by the following two statements, QMP36 and QMP37:

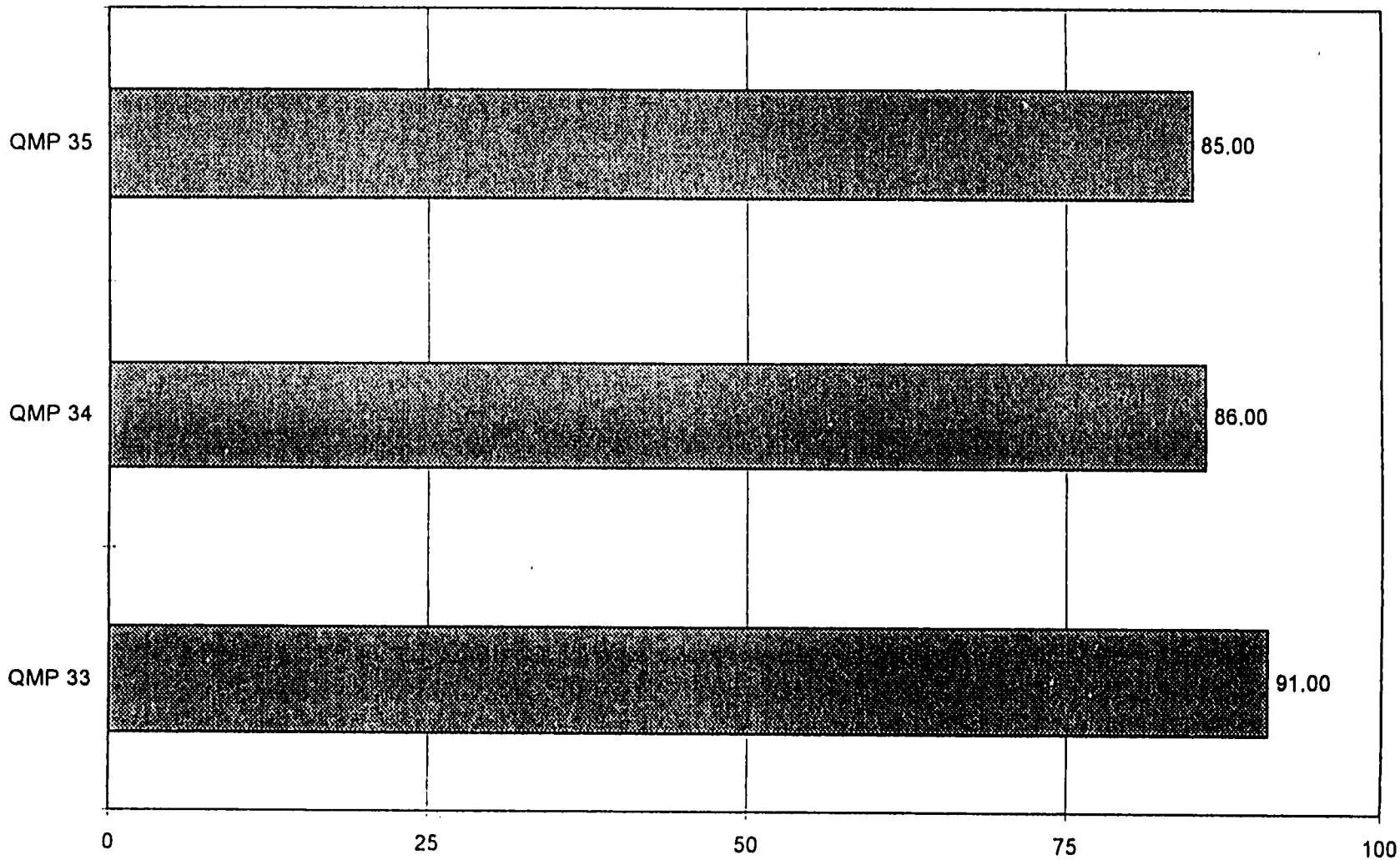


Figure 4.9 QMP Distribution for Design Changes

TABLE 4.10 RESPONSE STATISTICS FOR DESIGN CHANGES (QMA9)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 33	Any design changes affecting contractual requirements are made available in writing, and the client's and/or client's representative's approval obtained.	91.00	25.00	100.00	100.00	17.50	1	3
QMP 34	Design changes are identified and documented for easy retrieval.	86.00	50.00	100.00	100.00	22.91	2	17
QMP 35	Activities affected by design changes are identified and the concerned personnel duly notified.	85.00	25.00	100.00	100.00	30.62	3	20

- QMP36 - Subcontracted designers hired for designing special areas of the project are informed and selected according to the organization's quality programme.
- QMP37 - The organization works closely with any subcontracted designer to ensure unity of design.

The average prevelancy and response statistics of these statements are given in Figure 4.10 and Table 4.11 respectively.

A design organization sometimes has to hire specialist designers for the execution of certain part of the project. Ensuring that these subcontracted designers are informed and selected according to the organization's quality programme (QMP36) working closely with them (QMP37) provides the environment for creating a work of quality. The following possible reasons may account for not having a higher prevelancy rate for this quality management area:

- specialist designers are known to have a high standard of quality in their work as they have been working in that specialization for a reasonable period
- specialist designers are expected to adapt as much as possible to the organization's main designs.

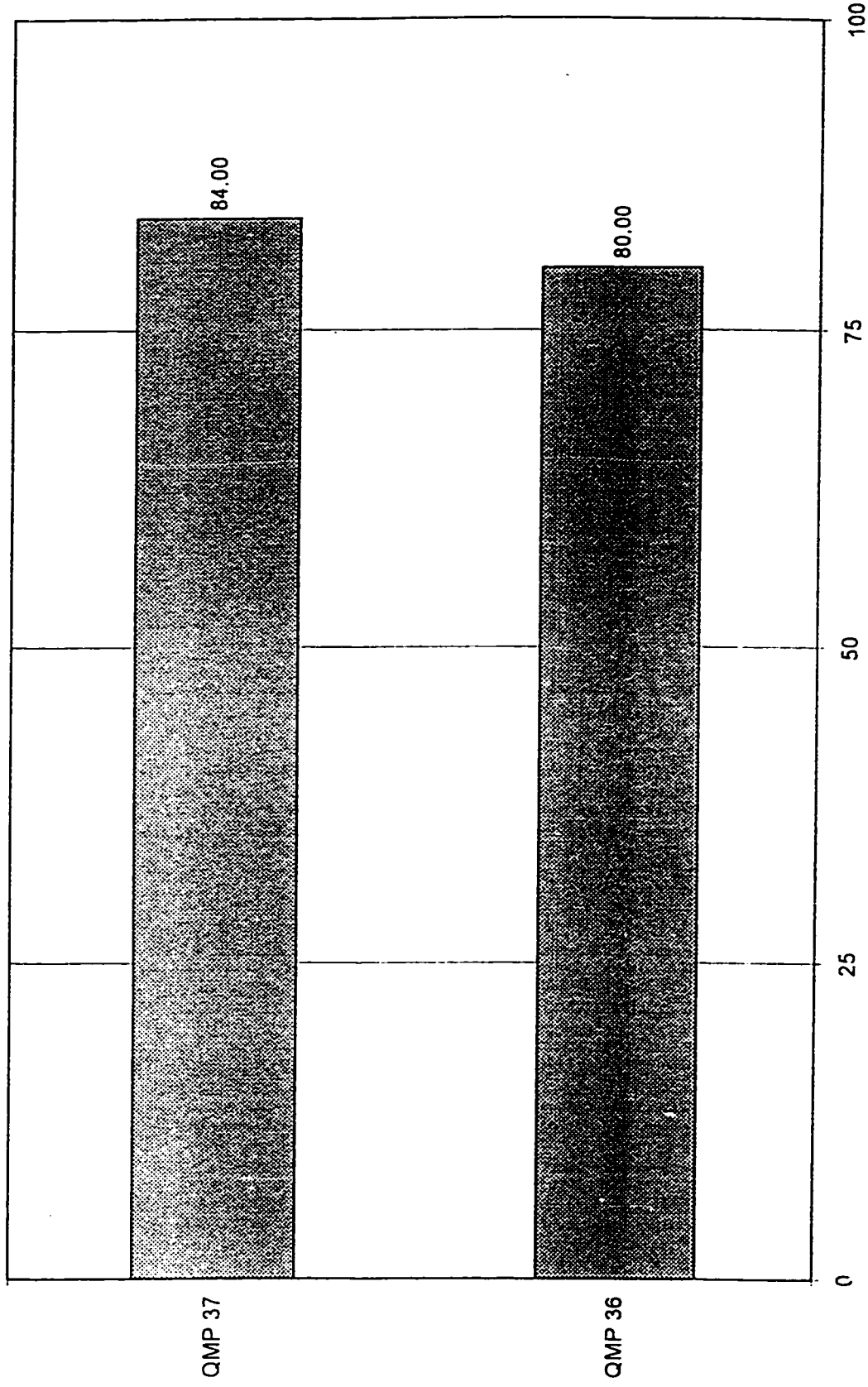


Figure 4.10 QMP Distribution for Subcontractor Control

TABLE 4.11 RESPONSE STATISTICS FOR SUBCONTRACTOR CONTROL (QMA10)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 36	Subcontracted designers hired for designing special areas of the project are informed and selected according to the organization's quality programme.	80.00	50.00	100.00	100.00	28.87	2	34
QMP 37	The organization works closely with any subcontracted designer to ensure unity of design.	84.00	0.00	100.00	100.00	31.36	1	22

4. 1 .11 Document Control

Document control was measured by the following four statements, QMP38-QMP41:

- QMP38 - All documents relating to the project are indexed and properly filed.
- QMP39 - All documents relating to the project are regularly updated.
- QMP40 - All documents relating to the project are easily available to the concerned personnel.
- QMP41 - Documents are revised and re-issued after practical number of changes have been issued.

The average prevelancy and response statistics of this quality management area are shown in Figure 4.11 and Table 4.12 respectively.

Proper document control is necessary for the success of any organization and more so for design organization. Thus it is no surprise that this quality management area ranks high in its prevelancy.

4. 1 .12 Design Maintainability

The following statements, QMP42 and QMP43, measure the design maintainability:

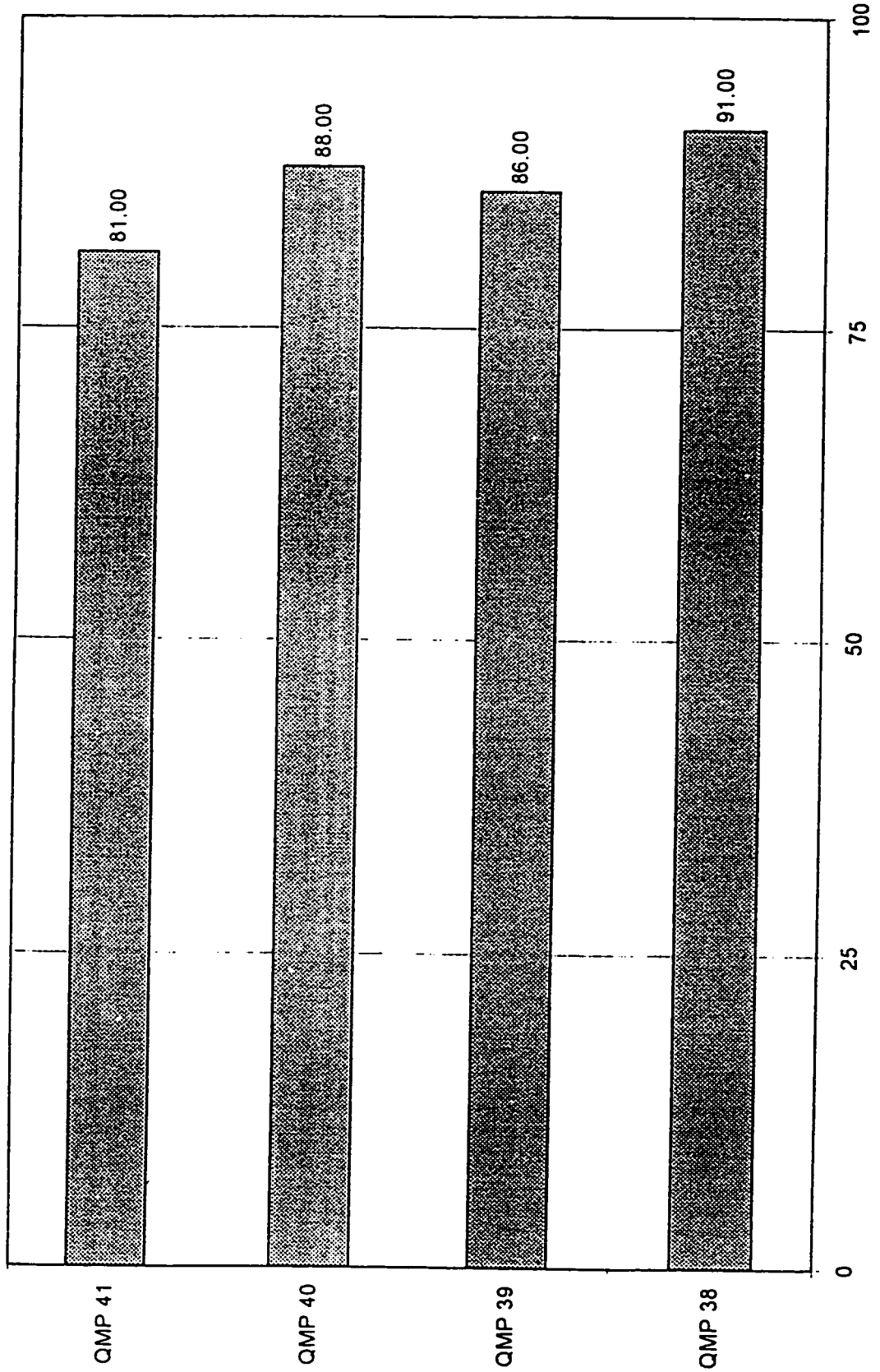


Figure 4.11 QMP Distribution for Document Control

TABLE 4.12 RESPONSE STATISTICS FOR DOCUMENT CONTROL (QMA11)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 38	All documents relating to the project are indexed and properly filed.	91.00	50.00	100.00	100.00	22.68	1	3
QMP 39	All documents relating to the project are regularly updated.	86.00	50.00	100.00	100.00	22.91	3	17
QMP 40	All documents relating to the project are easily available to the concerned personnel.	88.00	50.00	100.00	100.00	21.79	2	10
QMP 41	Documents are revised and re-issued after practical number of changes have been issued.	81.00	50.00	100.00	100.00	30.00	4	29

- QMP42 - Ease of maintainability and/or replacement is kept in mind when specifying materials in design.
- QMP43 - Provisions are made in the design to provide easy accessibility for any future project maintenance.

The average prevelancy and the response statistics of these two statements are given in Figure 4.12 and Table 4.13 respectively.

Ensuring maintainability and/or replacement facilitation in the design can go a long way in saving the client time and money in future maintenance of the project. A study by Al-Shiha (1993) revealed that design defects in ensuring maintenance practicality and adequacy was ranked seventh out of eleven factors by maintenance contractors and defects due to construction materials sixth in severity.

The only suggestion that the author can give in this quality management area, which has a good service rating, is to increase the prevelancy of QMP42.

4.1.13 Computer Usage

Computer usage in the organization was measured through the following two statements, QMP44 and QMP45:

- QMP44 - There is a frequent use of CAD tools.

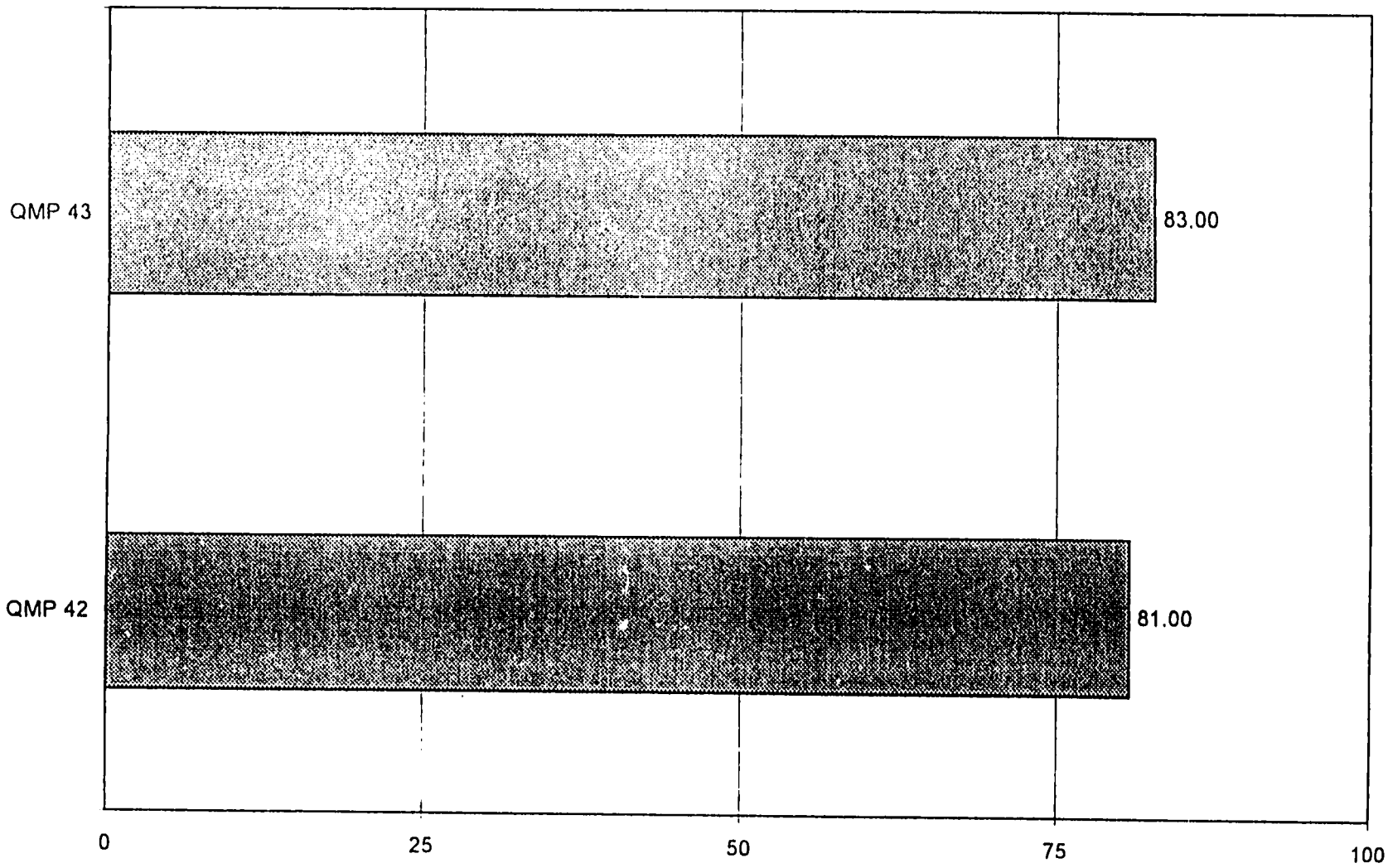


Figure 4.12 QMP Distribution for Design Maintainability

TABLE 4.13 RESPONSE STATISTICS FOR DESIGN MAINATAINABILITY (QMA12)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 42	Ease of maintainability and/or replacement is kept in mind when specifying materials in design.	81.00	50.00	100.00	100.00	25.29	2	29
QMP 43	Provisions are made in the design to provide easy accessibility for any future project maintenance.	83.00	50.00	100.00	100.00	18.71	1	25

- QMP45 - Computer softwares utilized in the design process are selected based on their accuracy and checked for any errors.

The average prevelancy and response statistics of this quality management area are given in Figure 4.13 and Table 4.14 respectively.

The average quality service rating of this quality management area ranks near the border of the "good' rating. The use of CAD tools lessens the amount of rework done and thus improving the productivity of the employees concerned. The reason for a slightly lower usage of CAD tools could be attributed to the organization not possessing that many computer trained draftsmen.

4. 1 .14 Working Relationship

This quality management area covers the largest number of quality management practices, statements QMP46 to QMP66, in this study. The average prevalency and response statistics of this quality management area are given in Figure 4.14 and Table 4.15 respectively.

For the sake of convenience this quality management area will be divided into two subgroups:

1. Working Relationship Solely With the Client
2. Working relationship Jointly With the Client and Contractor.

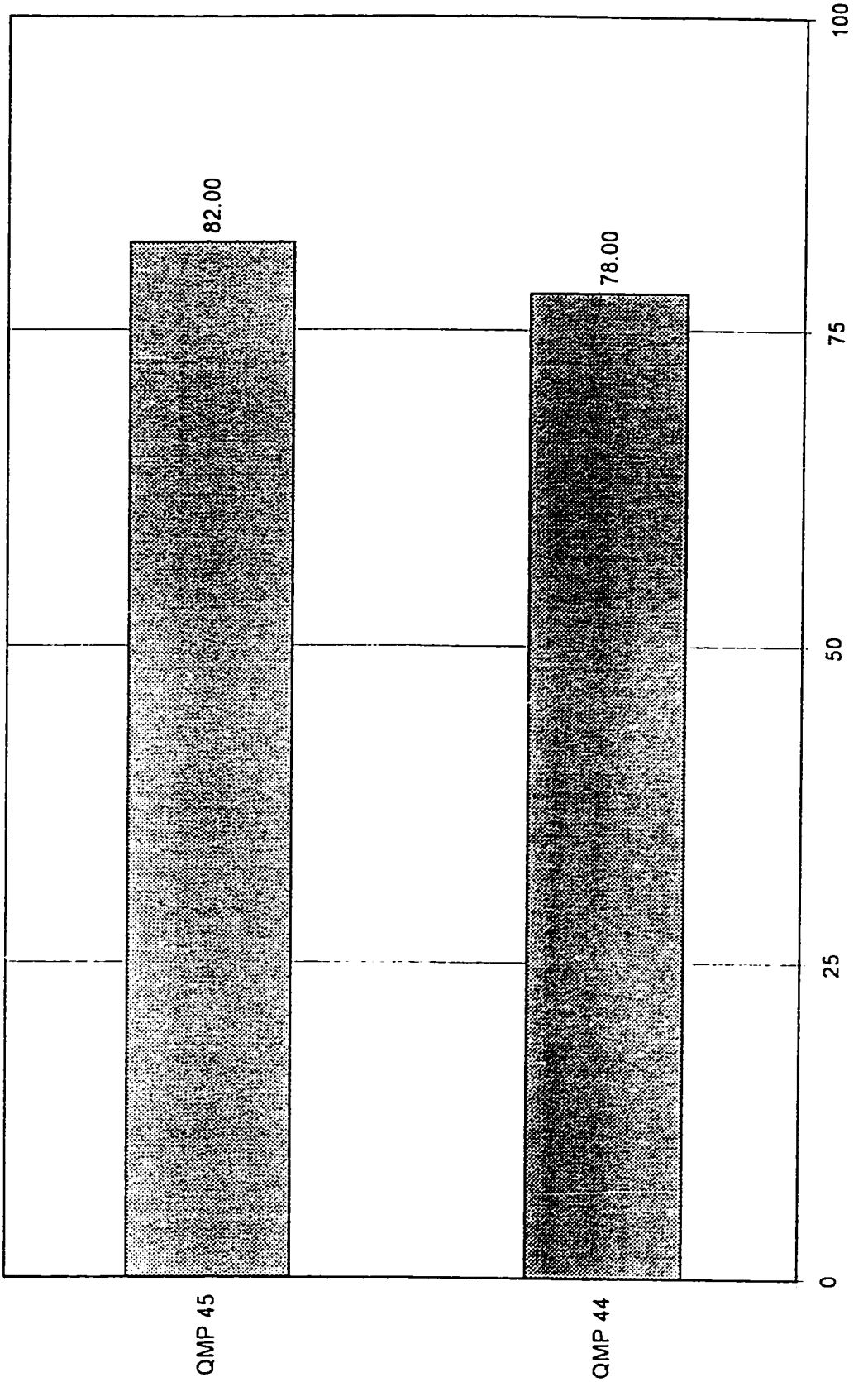


Figure 4.13 QMP Distribution for Computer Usage

TABLE 4.14 RESPONSE STATISTICS FOR COMPUTER USAGE (QMA13)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 44	There is a frequent use of CAD tools.	78.00	0.00	100.00	100.00	30.03	2	41
QMP 45	Computer softwares utilized in the design process are selected based on their accuracy and checked for any errors.	82.00	0.00	100.00	100.00	25.54	1	27

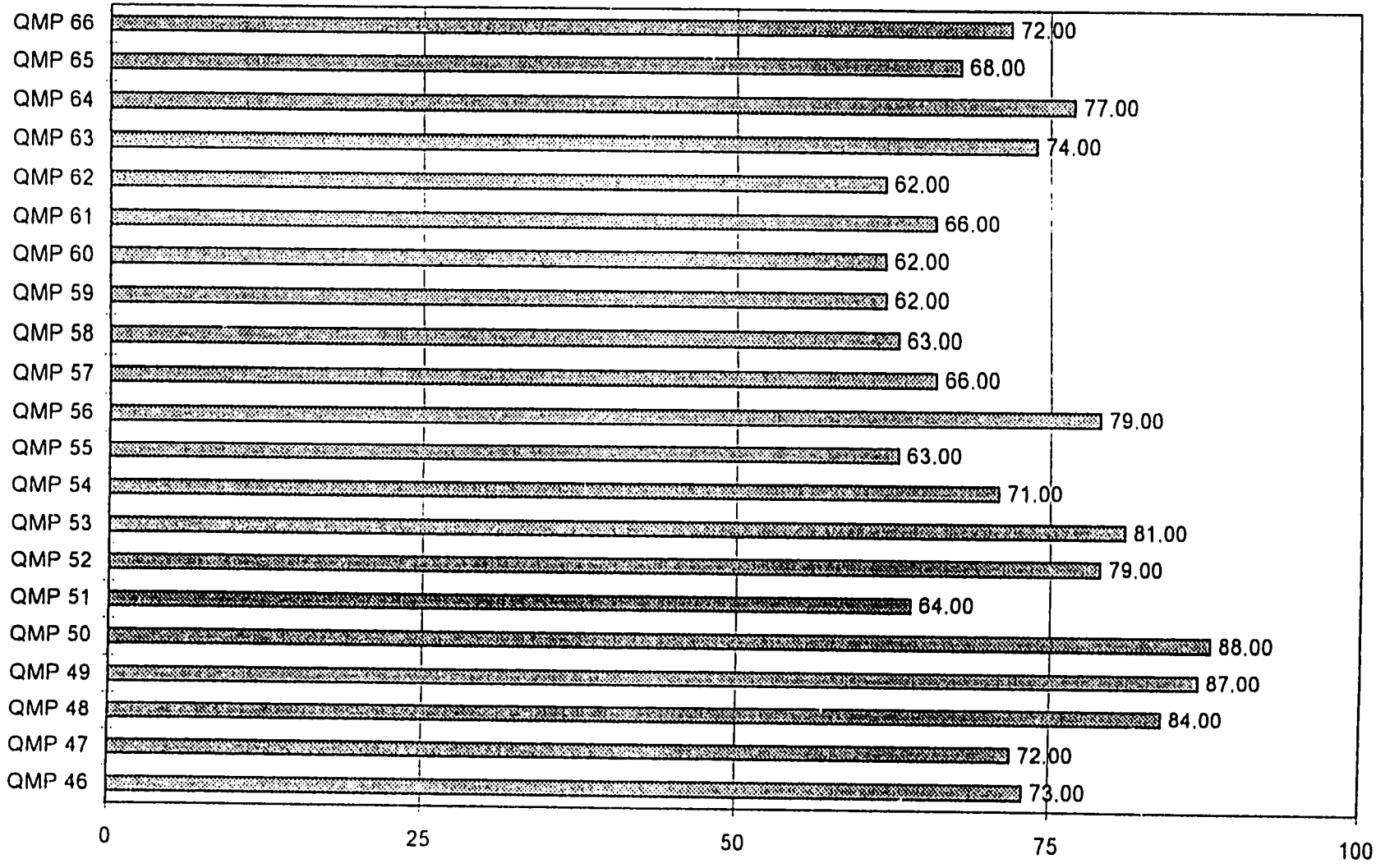


Figure 4.14 QMP Distribution for Working Relationship

TABLE 4.15 RESPONSE STATISTICS FOR WORKING RELATIONSHIP (QMA14)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 46	Roles of the project team members are defined through discussion with the client and/or client's representative.	73.00	25.00	100.00	100.00	29.69	9	48
QMP 47	Working procedures and communication lines are defined through discussion with the client and/or client's representative.	72.00	25.00	100.00	75.00	29.15	10	50
QMP 48	Project cost, schedule, and quality are defined through discussion with the client and/or client's representative.	84.00	50.00	100.00	100.00	24.87	3	22
QMP 49	Contractual requirements and constraints are defined through discussion with the client and/or client's representative.	87.00	50.00	100.00	100.00	22.96	2	15

TABLE 4.15 RESPONSE STATISTICS FOR WORKING RELATIONSHIP (QMA14) (cont.)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 50	Project requirements are defined through discussion with the client and/or client's representative.	88.00	50.00	100.00	100.00	22.96	1	10
QMP 51	Methods of testing design correctness are defined through discussion with the client and/or client's representative.	65.00	0.00	100.00	75.00	33.91	16	61
QMP 52	The complete project brief is developed through discussion with the client and/or client's representative.	79.00	25.00	100.00	100.00	28.58	5	38
QMP 53	Space utilization and material appropriateness is defined through discussion with the client and/or client's representative.	81.00	50.00	100.00	75.00	23.14	4	29

TABLE 4.15 RESPONSE STATISTICS FOR WORKING RELATIONSHIP (QMA14) (cont.)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 54	Methods for resolving design conflict are defined through discussion with the client and/or client's representative.	71.00	0.00	100.00	100.00	35.12	12	53
QMP 55	Location drawings and physical models are made for review.	63.00	0.00	100.00	75.00	28.06	17	63
QMP 56	The correctness of the scheme design with regard to the project brief is checked with the client and/or client's representative.	79.00	25.00	100.00	100.00	28.58	5	38

TABLE 4.15 RESPONSE STATISTICS FOR WORKING RELATIONSHIP (QMA14) (cont.)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 57	Constructability of the detail design is checked with the client and/or client's representative, and the construction contractor.	66.00	0.00	100.00	75.00	28.76	14	59
QMP 58	Specification class.fication is worked out with the client and/or client's representative, and the construction contractor.	63.00	25.00	100.00	50.00	28.98	17	63
QMP 59	Contractual details for construction are worked out with the client and/or client's representative, and the construction contractor.	62.00	0.00	100.00	50.00	28.98	19	65
QMP 60	Requirements for temporary works are worked out with the client and/or client's representative, and the construction contractor.	62.00	0.00	100.00	50.00	33.94	19	65

TABLE 4.15 RESPONSE STATISTICS FOR WORKING RELATIONSHIP (QMA14) (cont.)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 61	Degree of accuracy of the drawings and the detail required is established with the client and/or client's representative, and the construction contractor.	66.00	25.00	100.00	75.00	28.76	14	59
QMP 62	Practicality of the design drawings is verified with the client and/or client's representative, and the construction contractor.	62.00	0.00	100.00	50.00	34.70	19	65
QMP 63	Material and workmanship requirements are established with the client and/or client's representative, and the construction contractor.	74.00	25.00	100.00	100.00	28.39	8	47

TABLE 4.15 RESPONSE STATISTICS FOR WORKING RELATIONSHIP (QMA14) (cont.)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 64	Appropriate specifications and their details are worked out with the client and/or client's representative, and the construction contractor.	77.00	50.00	100.00	100.00	25.94	7	43
QMP 65	Procedures for communicating design inconsistencies and their correction is established with the client and/or client's representative, and the construction contractor.	68.00	0.00	100.00	100.00	32.69	13	55
QMP 66	There is regular review of the work performed by the construction contractor to help in any possible design changes required by the client and/or to improve project cost, schedule, and quality.	72.00	0.00	100.00	100.00	32.53	10	50

4. 1 .14 .1 Working Relationship Solely With the Client

The quality management practices measuring the design organization's working relationship solely with the client are as follows, QMP46 to QMP56:

- QMP46 - Roles of the project team members are defined through discussion with the client and/or client's representative.
- QMP47 - Working procedures and communication lines are defined through discussion with the client and/or client's representative.
- QMP48 - Project cost, schedule, and quality are defined through discussion with the client and/or client's representative.
- QMP49 - Contractual requirements and constraints are defined through discussion with the client and/or client's representative.
- QMP50 - Project requirements are defined through discussion with the client and/or client's representative.
- QMP51 - Methods of testing design correctness are defined through discussion with the client and/or client's representative.
- QMP52 - The complete project brief is developed through discussion with the client and/or client's representative.
- QMP53 - Space utilization and material appropriateness is defined through discussion with the client and/or client's representative.
- QMP54 - Methods for resolving design conflict are defined through discussion with the client and/or client's representative.

- QMP55 - Location drawings and physical models are made for review.
- QMP56 - The correctness of the scheme design with regard to the project brief is checked with the client and/or client's representative.

There is a low level of prevalency with the quality management practices defining the role of team members (QMP46) and working procedures (QMP47). The possible reasons for this situation could be the following:

- client does not give much importance to the quality practices
- design organization believes that its way of doing these things is justified and they do not need any input from others.

Quality management practices, QMP48 to QMP50, are highly prevalent, as these details need to be worked out with the client for the sake of the project and they are performed at the start of the relationship. Quality practices, QMP52, QMP53, and QMP56, are also prevalent but to a slightly lower degree than the above mentioned practices.

Among the less prevalent quality practices in this subgroup is the definition of methods for testing design correctness (QMP51) which has a lower prevalency than the definition of methods for resolving design conflicts (QMP54) as most design organizations leave it up to the client to test design correctness. Clients sometimes choose to test the correctness of the design by giving it to an another design office for peer review, and ensure that the other design office

remains anonymous. Location drawings and physical models (QMP55) are made mostly upon the direct request of the client and charged extra unless specified in the contract.

4. 1 .14 .2 Working Relationship Jointly With the Client and Contractor.

The following quality management statements, QMP57 to QMP66, measure the design organization's working relationship jointly with the owner and the contractor:

- QMP57 - Constructability of the detail design is checked with the client and/or client's representative, and the construction contractor.
- QMP58 - Specification classification is worked out with the client and/or client's representative, and the construction contractor.
- QMP59 - Contractual details for construction are worked out with the client and/or client's representative, and the construction contractor.
- QMP60 - Requirements for temporary works are worked out with the client and/or client's representative, and the construction contractor.
- QMP61 - Degree of accuracy of the drawings and the detail required is established with the client and/or client's representative, and the construction contractor.
- QMP62 - Practicality of the design drawings is verified with the client and/or client's representative, and the construction contractor.

- QMP63 - Material and workmanship requirements are established with the client and/or client's representative, and the construction contractor.
- QMP64 - Appropriate specifications and their details are worked out with the client and/or client's representative, and the construction contractor.
- QMP65 - Procedures for communicating design inconsistencies and their correction is established with the client and/or client's representative, and the construction contractor.
- QMP66 - There is regular review of the work performed by the construction contractor to help in any possible design changes required by the client and/or to improve project cost, schedule, and quality.

Interestingly as the contractor comes into the picture there is a decline in the prevalency of these quality management practices. Some of the respondents indicated that they sometimes prefer not to deal with the contractor and only with the client. and how the contractor deals with the contractor is none of their concern.

The reason for such a lower prevalency of quality management practices when dealing with the contractor than with the owner could be attributed to the traditional animosity between these two professions. This quality management area reveals some interesting trends:

- there is a higher degree of contact with the client in the beginning of the project than in later stages

- co-operation is mainly in areas vital for the successful completion of the contract
- design offices prefer to remain aloof from the contractors as compared with the clients.

4. 1 .15 Performance Quality Audit

The following four statements (QMP67-QMP70) measured the prevelancy of performance quality audit practices by the design organization:

- QMP67 - The organization keeps a record of all quality activities of the project with the results of any design verifications noted.
- QMP68 - After the end of the project, a study of the significant project characteristics is made for future reference.
- QMP69 - An evaluation by the client regarding the services provided is requested at the end of each project.
- QMP70 - An evaluation by the construction contractor regarding the working relationship is requested at the end of each project.

The average prevelancy and the response statistics of these quality management practices are shown in Figure 4.15 and Table 4.16 respectively.

This quality management area reveals some interesting observations about the design organizations. Although there is a good average prevalency of

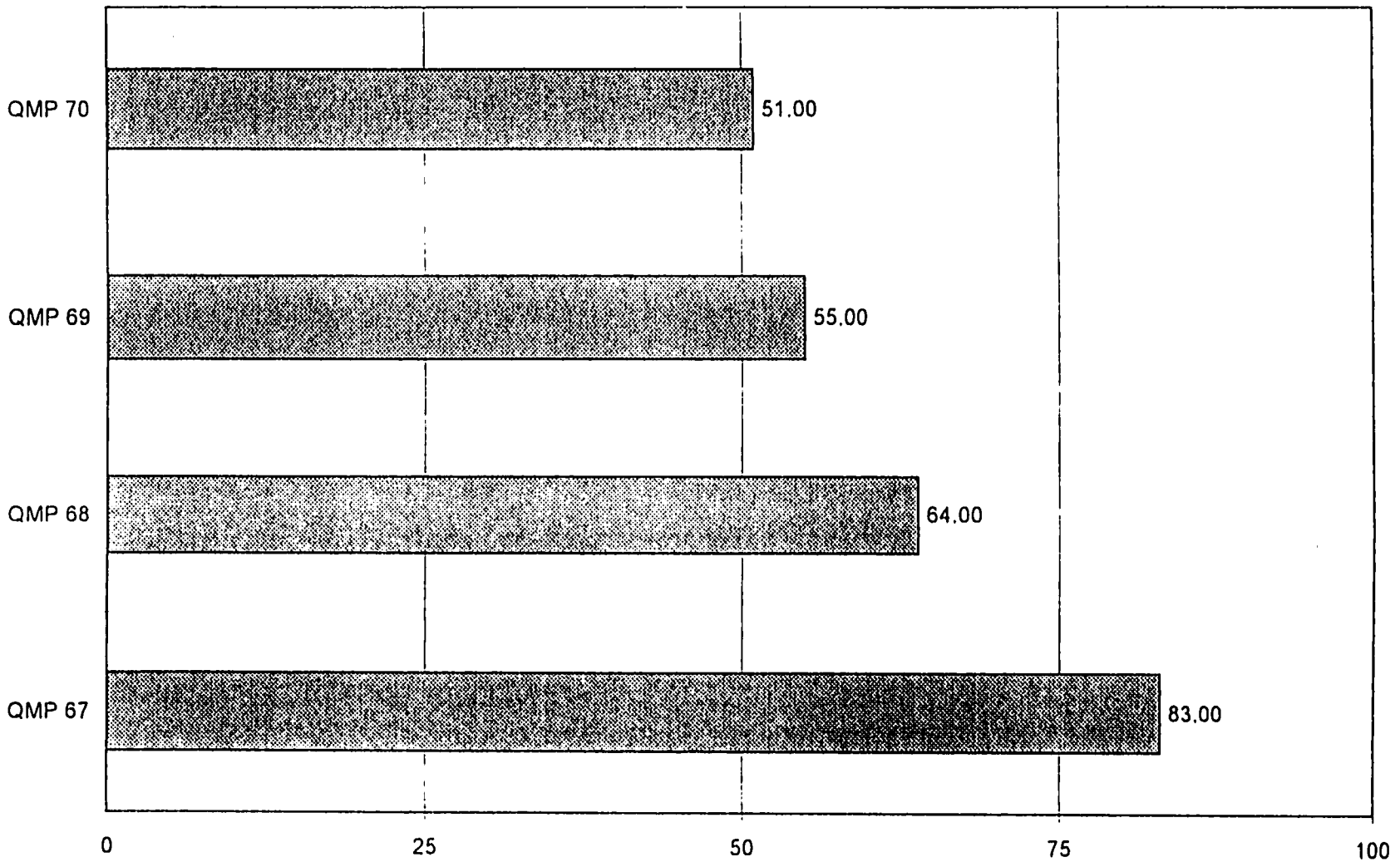


Figure 4.15 QMP Distribution for Performance Quality Audit

TABLE 4.16 RESPONSE STATISTICS FOR PERFORMANCE QUALITY AUDIT (QMA15)

QMP	Quality Management Practices	Avg. QMP	MIN	MAX	MODE	Std. Dev.	Rank in QMA	Overall Rank
QMP 67	The organization keeps a record of all quality activities of the project with the results of any design verifications noted.	83.00	0.00	100.00	100.00	22.50	1	25
QMP 68	After the end of the project, a study of the significant project characteristics is made for future reference.	64.00	0.00	100.00	50.00	31.52	2	62
QMP 69	An evaluation by the client regarding the services provided is requested at the end of each project.	55.00	0.00	100.00	50.00	29.76	3	69
QMP 70	An evaluation by the construction contractor regarding the working relationship is requested at the end of each project.	51.00	0.00	100.00	50.00	27.46	4	70

keeping quality records (QMP67) by the responding organizations there is a significant drop in prevalency in studying significant characteristics at the end of the project (QMP69). Studies done by the organization at the end of a project help the organization in learning from their experiences and help in developing ways for overcoming any similar problems faced in the future. Persistent problems revealed in end-of-the-project studies highlight areas were drastic action for improvement is needed by the organization.

The responses to the other two statements (QMP69 and QMP70) on evaluation by the owner and contractor respectively reveal a very low prevalency. End-of-the-project evaluations by both the owners and contractors helps the design organization in maintaining better relations by getting to know their grievances and appreciation. These quality management practices can be a great help in promoting partnering relationship in the future. At present these statistics reveal a clear lack of effort by the design organizations in requesting evaluation from the owner and more so from the contractor.

4. 1 .16 Summary of Discussion on Quality Management Areas

A study of the results of the prevalent quality management areas by the respondent organizations is given in Figure 4.16 and Table 4.17.

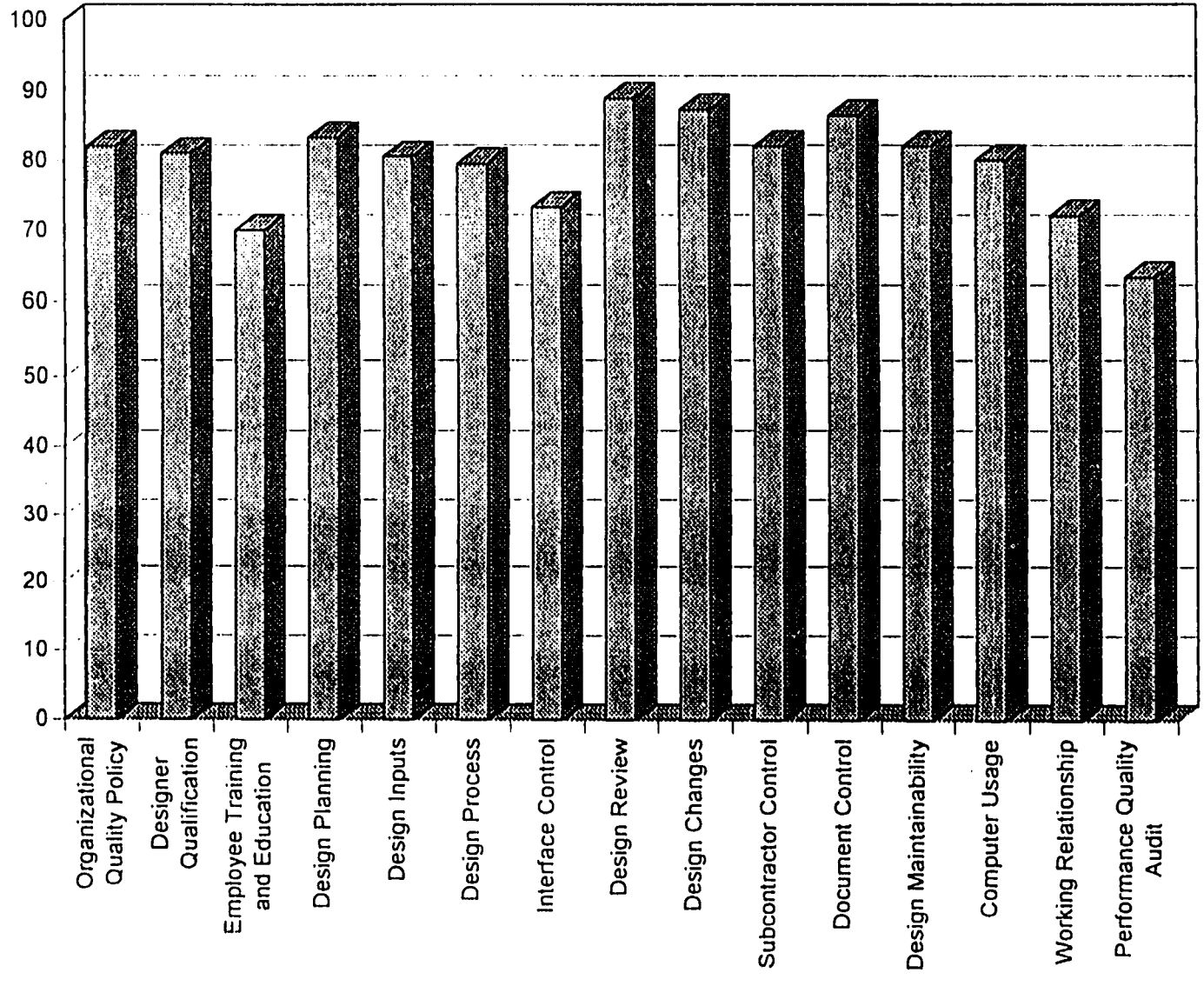


Figure 4.16 Prevelance of the Fifteen Quality Management Areas

TABLE 4.17 Response Statistics for the Fifteen Quality Management Areas

QMA	Quality Management Area	Avg. QMA	MIN	MAX	MODE	Std. Dev.	Overall Rank
QMA1	Organizational Quality Policy	82.00	0.00	100.00	100.00	22.99	5
QMA2	Designer Qualification	81.00	50.00	100.00	100.00	16.58	8
QMA3	Employee Training and Education	70.00	41.67	100.00	66.67	15.59	14
QMA4	Design Planning	83.33	50.00	100.00	100.00	16.67	4
QMA5	Design Inputs	80.50	25.00	100.00	75.00	17.34	9
QMA6	Design Process	79.50	33.33	100.00	95.83	15.21	11
QMA7	Interface Control	73.25	0.00	100.00	87.50	20.29	12
QMA8	Design Review	89.00	62.50	100.00	100.00	12.89	1
QMA9	Design Changes	87.33	25.00	100.00	100.00	20.29	2
QMA10	Subcontractor Control	82.00	0.00	100.00	100.00	28.43	5

TABLE 4.17 Response Statistics for the Fifteen Quality Management Areas (cont.)

QMA	Quality Management Area	Avg. QMA	MIN	MAX	MODE	Std. Dev.	Overall Rank
QMA11	Document Control	86.50	0.00	100.00	100.00	21.25	3
QMA12	Design Maintainability	82.00	25.00	100.00	100.00	20.12	5
QMA13	Computer Usage	80.00	0.00	100.00	100.00	25.00	10
QMA14	Working Relationship	72.07	0.00	100.00	94.05	21.78	13
QMA15	Performance Quality Audit	63.25	0.00	100.00	56.25	22.56	15
	Total	**79.45**	**44.05**	**100.00**	-	**12.36**	

The most prevalent quality management areas are Design Review, Design Changes, Document Control, and Design Planning. While the least prevalent areas are Performance Quality Audit, Employee Training and Education, Working Relationship, and Interface Control. Design organizations need to pay serious attention to their system to increase the prevalency of quality management practices in the above mentioned four least prevalent quality management areas.

Additional recommendations made by the respondents, and quality management practices practiced by some organizations are as follows:

- A separate QA/QC procedure devised on the guideline of ISO 9000 to suit any type of design job and the QA/QC procedure implemented and checked on monthly basis.
- Partnering approach should be taken by Owners, Consultants, and Construction Contractors for the benefit of the projects.

4. 2 QUALITY MANAGEMENT AREA IMPORTANCE RATINGS (QMAIR)

The respondents were requested to indicate the importance they feel for the quality management areas by giving values from one to ten, where one indicated the lowest importance and ten the highest importance. Table 4.18 gives the percentage of respondents indicating their response as equivalent to

TABLE 4.18 Percentage Frequency Responds for Quality Management Area Importance Ratings

QMP	Quality Management Area	1	2	3	4	5	6	7	8	9	10	None	Avg. QMAIR
QMA1	Organizational Quality Policy	0.00	0.00	4.00	0.00	0.00	8.00	16.00	10.00	6.00	48.00	8.00	7.86
QMA2	Designer Qualification	0.00	0.00	0.00	0.00	4.00	4.00	0.00	22.00	22.00	40.00	8.00	8.18
QMA3	Employee Training and Education	0.00	0.00	0.00	0.00	12.00	4.00	12.00	30.00	18.00	16.00	8.00	7.30
QMA4	Design Planning	0.00	0.00	4.00	0.00	0.00	4.00	0.00	28.00	12.00	40.00	12.00	7.68
QMA5	Design Inputs	0.00	0.00	4.00	0.00	4.00	0.00	0.00	22.00	22.00	40.00	8.00	8.06
QMA6	Design Process	0.00	0.00	0.00	0.00	0.00	12.00	12.00	26.00	10.00	32.00	8.00	7.74
QMA7	Interface Control	0.00	0.00	0.00	0.00	4.00	8.00	8.00	32.00	16.00	24.00	8.00	7.64
QMA8	Design Review	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.00	8.00	60.00	8.00	8.64

TABLE 4.18 Percentage Frequency Responds for Quality Management Area Importance Ratings (cont.)

QMP	Quality Management Area	1	2	3	4	5	6	7	8	9	10	None	Avg. QMAIR
QMA9	Design Changes	0.00	0.00	0.00	0.00	4.00	4.00	4.00	12.00	12.00	56.00	8.00	8.36
QMA10	Subcontractor Control	4.00	0.00	0.00	0.00	8.00	0.00	0.00	12.00	16.00	48.00	12.00	7.64
QMA11	Document Control	0.00	0.00	4.00	0.00	0.00	4.00	0.00	8.00	20.00	52.00	12.00	8.00
QMA12	Design Maintainability	4.00	0.00	0.00	0.00	0.00	0.00	12.00	24.00	8.00	44.00	8.00	7.92
QMA13	Computer Usage	4.00	0.00	0.00	0.00	4.00	4.00	4.00	16.00	12.00	48.00	8.00	7.92
QMA14	Working Relationship	0.00	0.00	0.00	0.00	0.00	4.00	12.00	12.00	12.00	44.00	16.00	7.52
QMA15	Performance Quality Audit	0.00	0.00	0.00	4.00	4.00	4.00	16.00	22.00	14.00	28.00	8.00	7.54

that importance rating, which range from one to ten. The response statistics for the fifteen quality management areas are given in Table 4.19.

The areas given the highest importance ratings are Design Review, Design Changes, Designer Qualification, and Design Inputs. While Employee Training and Education, Working Relationship, Performance Quality Audit, and Interface Control are given the lowest rankings.

An analysis (Table 4.20) of the prevalency rates of the quality management areas and the importance given to these areas by the respondents presents a interesting picture. As both sets of the data came from the same population, rank correlation analysis could not be done. Thus the analysis was done by ranking both the sets of data and determining the difference in ranks for that particular quality management area. The level of agreement between the prevalency of the quality management areas and their corresponding importance ratings was judged on the basis of difference in the respective ranks of the two sets of data. The lower the difference between the groups the higher the agreement and vice versa. For example QMA8 (Subcontractor Control) is ranked first both in prevelancy ratings and in the importance ratings, giving a rank difference of zero. This indicates a perfect agreement in the importance given to this quality management area and in its practice by the A/E consulting organizations and consequently ranked first in the agreement ranks. Conversely QMA4 (Design Planning) is ranked fourth in its prevelancy and tenth in the

TABLE 4.19 Response Statistics of the Fifteen Quality Management Area Importance Ratings

QMA	Quality Management Area	Average IR	MIN	MAX	MODE	Std. Dev.	QMAIR Rank
QMA1	Organizational Quality Policy	7.86	3	10	10	2.98	8
QMA2	Designer Qualification	8.18	5	10	10	2.78	3
QMA3	Employee Training and Education	7.30	5	10	8	2.66	15
QMA4	Design Planning	7.68	3	10	10	3.30	10
QMA5	Design Inputs	8.06	3	10	10	2.94	4
QMA6	Design Process	7.74	6	10	10	2.70	9
QMA7	Interface Control	7.64	5	10	8	2.68	11
QMA8	Design Review	8.64	8	10	10	2.74	1
QMA9	Design Changes	8.36	5	10	10	2.87	2
QMA10	Subcontractor Control	7.64	1	10	10	3.58	11

TABLE 4.19 Response Statistics of the Fifteen Quality Management Area Importance Ratings (cont.)

QMA	Quality Management Area	Average IR	MIN	MAX	MODE	Std. Dev.	QMAIR Rank
QMA11	Document Control	8.00	3	10	10	3.40	5
QMA12	Design Maintainability	7.92	1	10	10	3.07	6
QMA13	Computer Usage	7.92	1	10	10	3.17	6
QMA14	Working Relationship	7.52	6	10	10	3.56	14
QMA15	Performance Quality Audit	7.54	4	10	10	2.79	13

TABLE 4.20 Agreement Analysis Between the Average QMA Prevalency Rates and QMAIR

QMA	Average IR	QMAIR Rank	Avg. QMA	QMA Rank	Rank Diff.	Agreement Rank
QMA1	7.86	8	82.00	6	2	7
QMA2	8.18	3	81.00	8	-5	12
QMA3	7.30	15	70.00	14	1	5
QMA4	7.68	10	83.33	4	6	15
QMA5	8.06	4	80.50	9	-5	12
QMA6	7.74	9	79.50	11	-2	7
QMA7	7.64	11.5	73.25	12	-0.5	3
QMA8	8.64	1	89.00	1	0	1

TABLE 4.20 Agreement Analysis Between the Average QMA Prevalency Rates and QMAIR (cont.)

QMA	Average IR	QMAIR Rank	Avg. QMA	QMA Rank	Rank Diff.	Agreement Rank
QMA9	8.36	2	87.33	2	0	1
QMA10	7.64	11.5	82.00	6	5.5	14
QMA11	8.00	5	86.50	3	2	7
QMA12	7.92	6.5	82.00	6	0.5	3
QMA13	7.92	6.5	80.00	10	-3.5	11
QMA14	7.52	14	72.07	13	1	5
QMA15	7.54	13	63.25	15	-2	7

importance given to it, giving a rank difference of six. This indicates a disagreement in the importance given to this quality management area and its practice.

The positive and negative values also provide an insight into the current working service of the A/E consulting organizations. The rank difference is taken as the difference between the 'QMAIR rank' and the 'QMA rank'. Thus a higher positive value of the rank difference indicates an extra effort by the organizations in providing greater quality service in that quality management area than that represented by the importance given to that quality management area. A higher negative value of the rank difference indicates a greater need for the organizations to improve the quality of their service in that quality management area to match the importance given to it.

The highest degree of agreement between the prevalency rates and the importance rates are given to the following quality management areas:

- Design Changes
- Design Review
- Interface Control
- Design Maintainability

While the lowest agreements between prevalency rates and importance ratings are given to the following:

- Design Planning
- Subcontractor Control
- Designer Qualification
- Design Inputs

The quality management areas were organizations are putting in an extra effort than that represented by the importance given to that quality management area are listed as follows, in descending order:

- Design Planning
- Subcontractor Control
- Organizational Quality Policy
- Document Control
- Working Relationship
- Employee Training and Education
- Design Maintainability

Design Changes and Design Review have a zero rank difference between their importance rankings and prevelancy rankings. While the following quality management areas, listed with the area needing a greater effort to catch up to importance rating first and vice versa, have negative rank differences:

- Designer Qualificatien
- Design Inputs

- Computer Usage
- Performance Quality Audit
- Design Process
- Interface Control

4. 3 ASSESSING THE SERVICE QUALITY OF DESIGN ORGANIZATIONS

The average service quality area of each organization is assessed by marking the average prevalency rate in each quality management area on a radar graph. Then the marked points are connected and area covered is denoted as service quality area. The value of the average service quality area of the organization is determined as the average of all the quality management areas. Figure 4.17 gives the average service quality of the responding organizations while the average service quality of each organization is represented individually in the same graphical format as Figure 4.17 in Appendix III.

The distribution of the average service quality of the responding organizations, illustrated in Figure 4.18, reveals a sample that is highly skewed to the left (negatively skewed). The skewness (γ) of the sample is determined by the following equation (Snedecor and Cochran 1971):

$\gamma = m_3 / (m_2 \times \sqrt{m_2})$

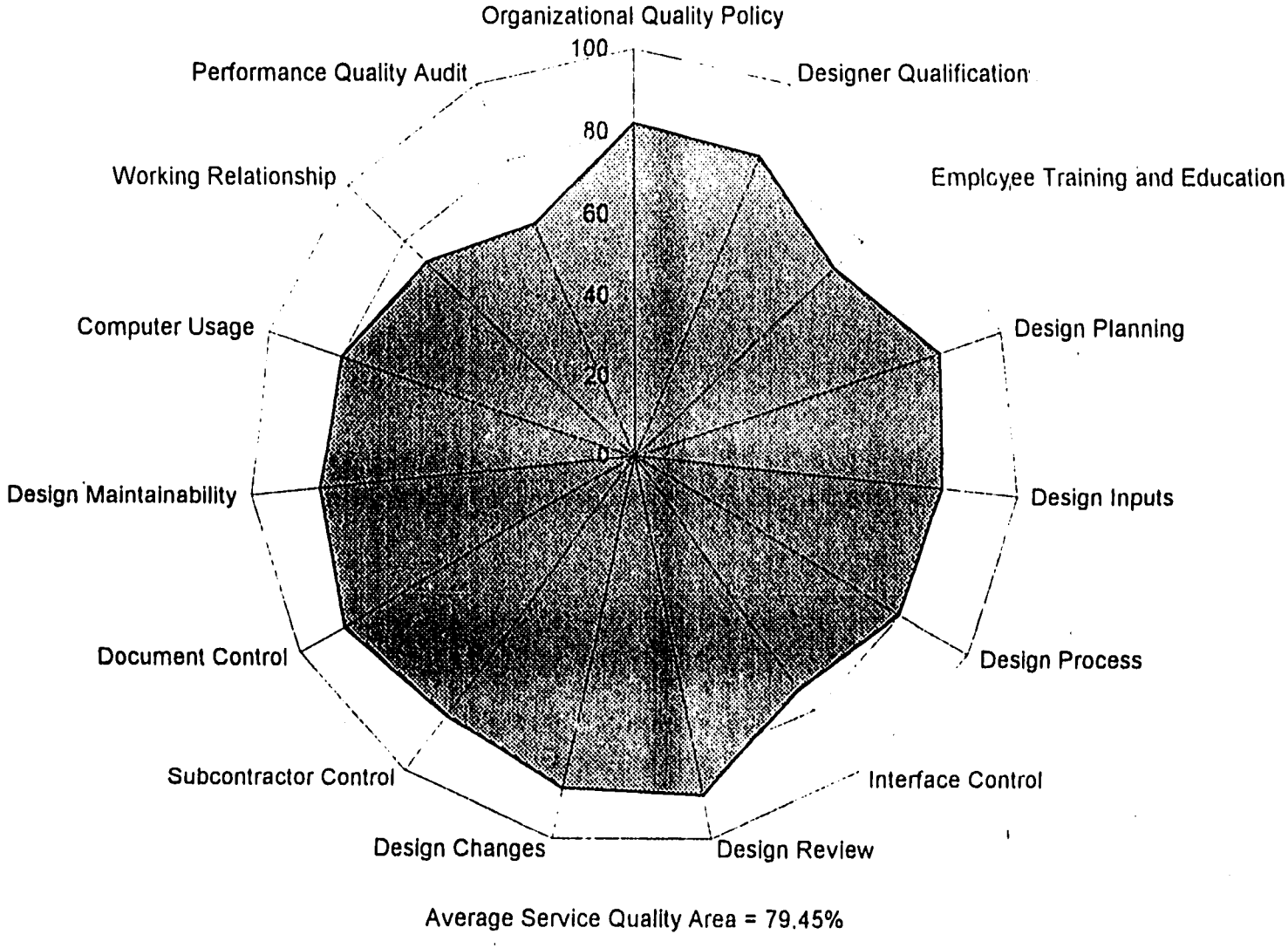


Figure 4.17 Average Service Quality Area of the Local Design Organizations

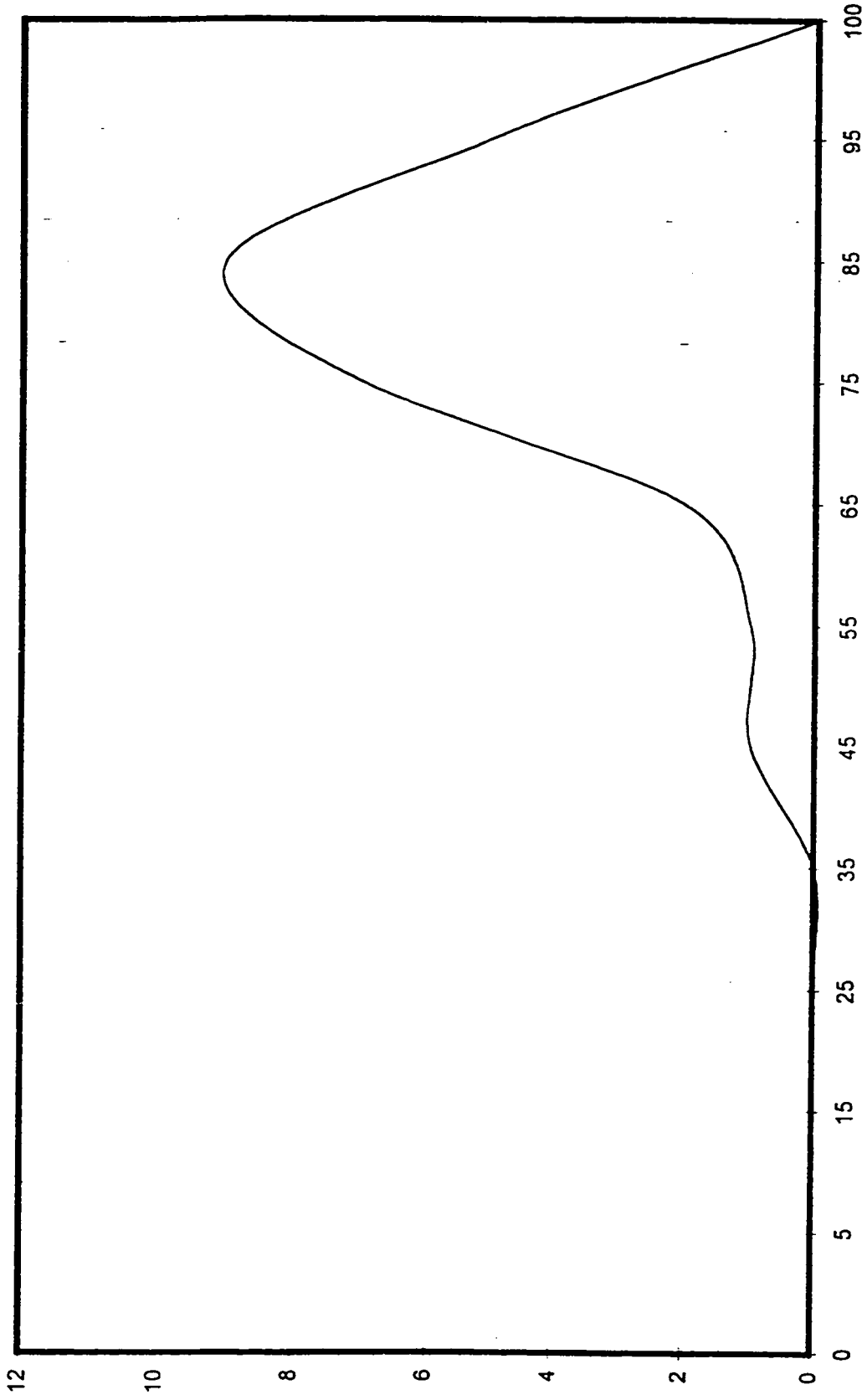


Figure 4.18 Distribution of the Service Quality of the Responding Organizations

where

$m_3 = \Sigma (X - \mu)^3 / n$

$m_2 = \Sigma (X - \mu)^2 / n$

X = service quality of the organization

μ = average service quality of the sample

n = sample population.

This equation gives the value of skewness as $\gamma = - 0.868$, confirming the highly skewed nature of the sample. This high negative skewness of the sample indicates an awareness of the importance of quality among the A/E consulting organizations.

For the sake of judgment a scale based on the probability distribution of the sample, for defining the service quality level of the organizations, is devised. The average service quality of the sample ($\mu = 79.45$) is approximated as $\mu = 80$; and the standard deviation of the sample ($\sigma = 12.36$) is approximated as $\sigma = 12.5$ for defining the scale as follows (Figure 4.19):

- 'Excellent', prevalence level range from above ($\mu + 1.5\sigma$), i.e., 98.75 percent.
- 'Good', prevalence level range from above ($\mu + 0.5\sigma$) to ($\mu + 1.5\sigma$), i.e., 86.25 to 98.75 percent.
- 'Average', prevalence level range from above ($\mu - 0.5\sigma$) to ($\mu + 0.5\sigma$), i.e., 73.75 to 86.25 percent.
- 'Unsatisfactory', prevalence level from above ($\mu - 1.5\sigma$) to ($\mu - 0.5\sigma$), i.e., 61.25 to 73.75 percent.

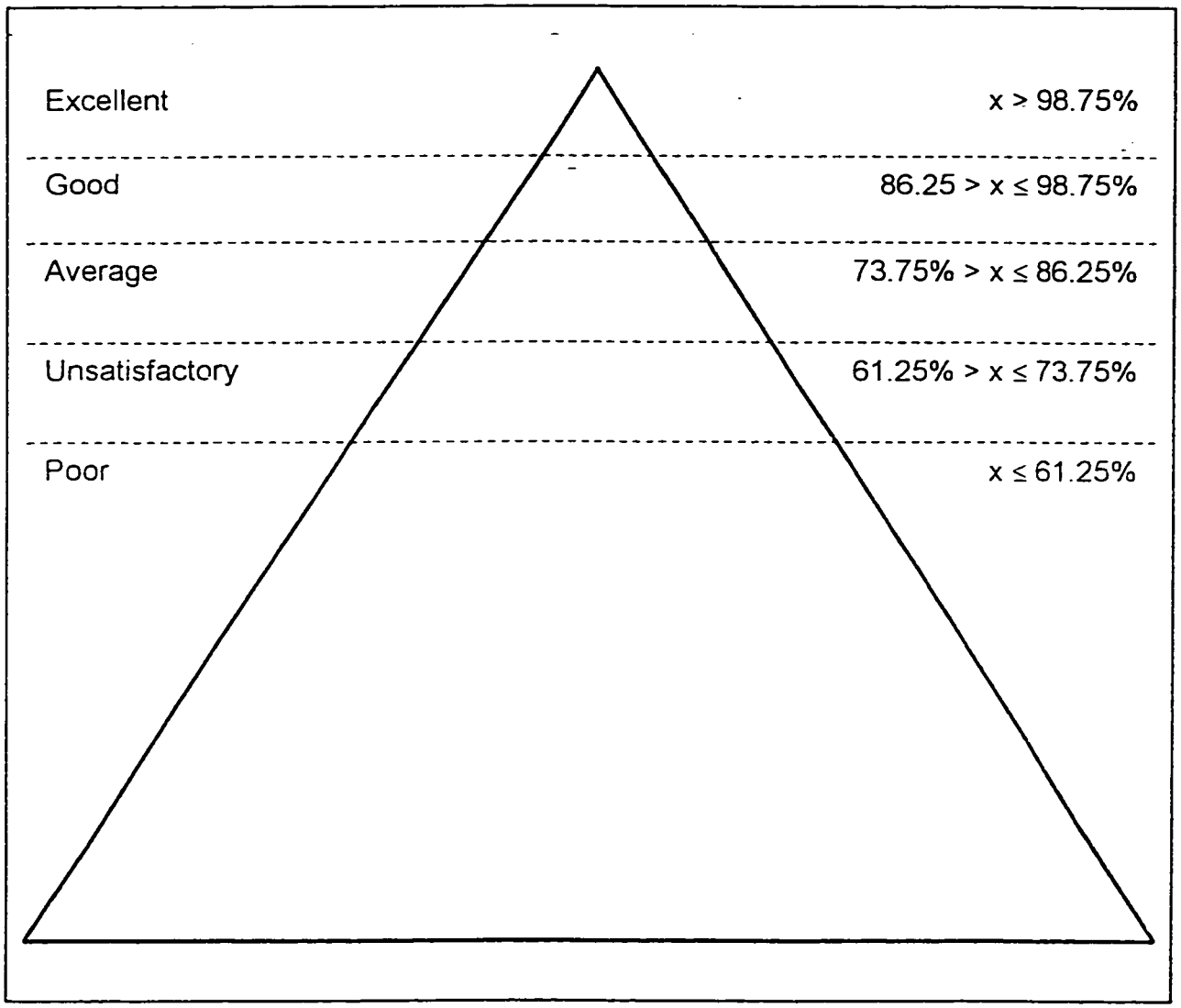


Figure 4.19 Scale for Measuring the Organization's Service Quality

- 'Poor', prevalence level below (μ - 1.5σ), i.e., 61.25 percent.

The lack of quantitative symmetry in the defining of ranges for the qualitative ratings is due to the high negative skewness of the sample.

The distribution of the organizations as per their service quality ratings is given in Table 4.21, while the average service quality of each organization is represented individually in the same graphical format as Figure 4.18 in Appendix 3. The organizations were rated on the basis of their service quality with the scale represented in Figure 4.1. Thus in Table 4.21 three organizations were judged as 'Excellent', and two organizations judged as 'Poor" on the basis of their organization's service quality.

These results highlight the need for improving the service provided by the design organizations in the local construction industry by adopting and practising the relevant quality management practices.

TABLE 4.21 ORGANIZATIONAL DISTRIBUTION ACCORDING TO THE SERVICE QUALITY

Service Quality Rating	Rating Range	No: of Organizations	Percentage of Organizations	Organizations in Range (decreasing order)
Excellent	$x \geq 98.75\%$	1	4%	5
Good	$86.25\% \leq x < 98.75\%$	6	24%	18, 2, 9, 3, 11, 21
Average	$73.75\% \leq x < 86.25\%$	10	40%	13, 7, 10, 4, 14, 17, 20, 6, 8, 25
Unsatisfactory	$61.25\% \leq x < 73.75\%$	6	24%	12, 24, 19, 16, 15, 1
Poor	$x < 61.25\%$	2	8%	23, 22

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5. 1 SUMMARY

The growing awareness in the local construction industry of quality management has led many organizations to adopt practices aimed at providing the customer the best service possible and staying competitive. The most important phase of any construction process is the design process, and as thus it is vital for the A/E consulting organization to ensure the quality of its services.

Chapter one introduced the topic of quality in construction, and the vital importance of quality in the design process. The importance of determining the prevalent quality management practices and increasing their awareness among the A/E consulting organizations were identified as significant parts of the study. The objectives of the study formulated as determining the following:

1. What are the quality management practices prevalent among the A/E organization?
2. What areas of the quality management system are practiced?
3. To what extent are the different areas of the quality management system developed?

4. What is the quality of service provided by the A/E consulting organizations?

The study was limited to the A/E consulting organizations in the Eastern Province of Saudi Arabia.

Chapter two stressed the importance of quality management through literature review. Studies highlighting the need for quality in the design process were presented. Previous researches related to A/E organizations in Saudi Arabia and their findings were also presented. Fifteen quality management areas, identified as having a bearing on the quality of service provided by the A/E consulting organizations are also discussed in this chapter. The fifteen quality management areas are as follows:

- Organizational Quality Policy
- Employee Training And Education
- Design Inputs
- Interface Control
- Design Changes
- Document Control
- Computer Usage
- Performance Quality Audit
- Designer Qualification
- Design Planning
- Design Process
- Design Review
- Subcontractor Control
- Design Maintainability
- Working Relationship

In chapter three, the methodology of the conducting the research was defined. Allocation of the seventy statements (Appendix I), designed to measure the quality management practices of the A/E consulting organizations, and the

determination of the sample size is also presented in this chapter. A survey of the quality management practices, outlined in Appendix I, was undertaken to determine their prevalence in the local construction industry. Of the total population of one hundred and forty A/E consulting offices, twenty-five participated in this study.

The surveyed quality management practices (QMP) were grouped into fifteen quality management areas (QMA) for classification. This classification ensured that the service quality of that quality management area was dependent on the practice of multiple quality management practice instead of one. This also gives the study a greater degree of accuracy and understanding in the determination of the true state of the local A/E consulting organizations, than if each quality management area was measured by a lone statement.

In chapter four, the results of the survey responses were presented. The results of the fifteen quality management areas were analyzed and the prevalence of each quality management area presented. The agreement level in the ranking between the prevalence of quality management areas and the importance given to these quality management areas was also determined. This analysis highlighted the need for organizations to put an extra effort to improve their quality of service in certain quality management areas, so as to be in concordance with the importance given by them to these quality management areas.

The average service quality of the local A/E consulting organizations was also presented in chapter four. The average service quality of the local consulting organizations was determined by taking the overall average of the fifteen quality management areas.

5. 2 CONCLUSIONS

The most prevalent quality management areas are design review, design changes, document control, and design planning. While the lowest prevalent areas are performance quality audit, employee training and education, working relationship, and interface control.

The areas given the highest importance ratings are design review, design changes, designer qualification, and design inputs. While employee training and education, working relationship, performance quality audit, and interface control are give the lowest rankings.

The highest degree of agreement between the prevalency rates and the importance rates is among the following quality management areas: design changes, design review, interface control, and design maintainability. While the lowest agreements between prevalency rates and importance ratings

are among the following quality management areas: design planning, subcontractor control, designer qualification, and design inputs.

The comparison of the ranking between the prevalence and importance given to the quality management area indicated the extra effort being put by the organizations in certain areas and a lack of effort in others, to be consistent with the importance given to those areas. The areas were an extra effort is being put in as compared to the importance given to them are design planning, subcontractor control, organizational quality policy, document control, working relationship, employee training and education, and design maintainability. This indicates a healthy attitude towards these quality management areas. The practice of two quality management areas, design review and design changes, was consistent with importance ranking of these two areas. On the other side of the spectrum designer qualification, design inputs, computer usage, performance quality audit, design process, and interface control revealed a lack of effort in the practice of these quality management areas in concordance with the importance given to them. This indicates a possible potential for complacency and needs to be monitored as a check against it.

In the assessment of service quality of each responding organization (Appendix 2) as per the scale in Figure 4.19; one organization were rated as providing an excellent service, six as providing a good service, ten providing an

average service, six providing an unsatisfactory service, and two as providing a poor service.

A summary of important conclusions reached in each of the fifteen quality management areas is given in Table 5.1. Some other important conclusions reached after discussions with some of the respondents are as follows:

- Need for ways to define and ensure the quality of service provided by the A/E consulting organizations (preferably by regulatory bodies).
- Development of a method for defining A/E consulting organization, on the basis of their service quality, in different grades, on the lines of grades applied to contractors.

5. 3 RECOMMENDATIONS

The following recommendations are made by the author in the hope of increasing the service quality of the A/E consulting organizations:

1. The development of a standard design code for the local construction industry
2. Research to be done on the feasibility of developing a system for evaluating the total service quality of the A/E consulting organization as per the characteristics of the local construction industry

TABLE 5.1 QUALITY MANAGEMENT AREA CONCLUSIONS

S. No.	Quality Management Areas	Important Conclusions (Summarized)
1	Organizational Quality Policy	Need for more effort in establishing and updating the quality manual.
2	Designer Qualification	Strong need for establishment of a design code for Saudi Arabia.
3	Employee Training and Education	Second least prevalent QMA. High need for more job training and provision of short courses to train local workforce.
4	Design Planning	Ned for more emphasis towards identifying design interfaces in preliminary design.
5	Design inputs	Slight need for identifying and defining responsibilities of transmission of design inputs.
6	Design Process	Need for more assignment of project work to a single team. Need for more trust and cooperation with contractor, to increase the prevalency of specifying important construction methods in design documents.
7	Interface Control	Need for greater interface control, and confirmation in writing of informally transmitted information between interfacing entities.
8	Design Review	The most prevalent QMA. A slight increase in the prevalency of aesthetic review is recommended.
9	Design Changes	The second most prevalent QMA.
10	Subcontractor Control	Very slight need for more emphasis in selecting and controlling subcontractor organizations.
11	Document Control	The third most prevalent QMA.
12	Design Maintainability	Slight need for ensuring ease of maintainability while specifying material in design documents.
13	Computer Usage	Need for more frequent use of CAD tools.
14	Working Relationship	Need for encouraging more client interaction. High need for building up more trust and cooperation with the contractor.
15	Performance Quality Audit	High need for end of the project studies for future reference. Urgent rectification of the current low prevalence of evaluation request from the client and the contractor at the end of the project.

3. Need for regulatory authorities to conduct regular audits of A/E consulting organizations as a way for ensuring that certain criteria for quality are maintained by the organizations
4. Study of ways to promote better cooperation between the A/E-Owner and the A/E-Contractor interfaces
5. The development of a prequalification system as an aid in the proper selection of an A/E consulting organization.

REFERENCES

1. Al-Musaid, A. A. (1990). *The Influence of Owner Involvement During Construction Process on Project Quality*, MS Thesis, King Fahd University of Petroleum and Minerals.

2. Al-Shiha, M. M. (1993). *The Effects of Faulty Design and Construction on Building Maintenance*, MS Thesis, King Fahd University of Petroleum and Minerals.

3. Assaf, S., Al-Hammad, A., and Al-Shiha, M. (1996). 'Effects of Faulty Design and Construction on Building Maintenance', *Journal of Performance of Constructed Facilities*, Vol. 10, No. 4, pp. 171-174.

4. ASCE (1990). *Quality in the Constructed Project*, Manual of Professional Practice, New York.

5. Bubshait, A. A. and Al-Abdulrazzak, A. (1996). 'Design Quality Management Activities', *Journal of Professional Issues in Engineering Education and Practice*, Vol. 122, No. 3, pp. 104-106.

6. Burati, J. L., Farrington, J. J., and Ledbetter, W. B. (1992). 'Causes of Quality Deviations in Design and Construction', *Journal of Construction Engineering and Management*, Vol. 118, No. 1, pp. 34-46.

7 Cornick, Tim (1991). *Quality Management for Building Design*, Butterworth-Heinemann Ltd, Great Britain.

8. Crosby, P. B. (1979). *Quality is Free*, McGraw-Hill Book Company, New York.

9. Ebrahimpour, M. (1988). 'An Empirical Study of American and Japanese Approaches to Quality Management in the United States', *International Journal of Quality and Reliability Management*, Vol. 5, No. 5, pp. 5-24.

10. Fox, M. J. (1993). *Quality Assurance Management*, Chapman and Hill, London.

11. Glover, J. (1993). 'Achieving the Organizational Change Necessary for Successful TQM', *International Journal of Quality and Reliability Management*, Vol. 10, No 6, pp. 47-64.

12. Harber, D., Burgess, K., and Barclay, D. (1993). 'Total Quality Management as a Cultural Intervention: An Integrative Review', *International Journal of Quality and Reliability Management*, Vol. 10, No. 6, pp. 17-27.

13. Hutchins, G. (1993). *ISO 9000: A Comprehensive Guide to Registration, Audit Guidelines, and Successful Certification*, Oliver Wright Publicatins, Inc., Vermont.

14. Johnson, R. S. (1993). *TQM: Management Process for Quality Operations*, ASQC, Quality Press, Milwaukee, Wisconsin 53202.

15. Kirby, J. G., Furry, D. A., Hiks, D. K. (1988). 'Improvements in Design Review Management', Journal of Construction Engineering and Management, Vol. 114, No. 1, pp. 69-82.

16. Kish, Leslie (1995). *Survey Sampling*, John Wiley and Sons. Inc., New York.

17. Lakhe, R. R., and Mohanty, R. P. (1994). 'Total Quality Management Concepts, Evolution and Acceptability in Developing Economies', *International Journal of Quality and Reliability Management*, Vol. 11, No. 9, pp. 9-33.

1 . Lascelles, D. M, and Dale, B. G. (1988). 'A Review of the Issues Involved in Quality Improvement', *International Journal of Quality and Reliability Management*, Vol. 5, No. 5, pp. 76-94.

19. Longenecker, C. O, and Scazzero, J. A. (1993). 'Total Quality Management from Theory to Practice: A Case Study', *International Journal of Quality and Reliability Management*, Vol. 10, No. 5, pp. 24-31.

20. March, A. (1996). 'A Note on Quality: The Views of Deming, Juran, and Crosby', IEEE Engineering Management Review, Vol. 24, No. 1, pp. 6-14.

21. McLaughlin, J. E. (1995). 'Practical Applications of Quality Management on Major Constrction Projects', *Proceedings of the Third Middle East International Quality Assurance Conference (24-26 April 1995)*, Bahrain, pp. 119-138.

2 .Mirams, M., and McElheron, P. (1995). *Gaining and Maintaining the New Quality Standard: The BS EN ISO 9000 Tool Kit*, Pitman Publishing, London.

23. Morgen, E. T. (1986). *Claims by the Federal Government Against its A/E: Guidelines for Improving Practice*, Office for Professional Liability, Research of Victor O. Schinner and Co., Washington, D. C.

4. Motor Columbus, Spie Batignolles, and Socotec (1984). *Quality Management Standard for Civil Works*, The Macmillan Press Limited, London and Basingstoke.

25. Peach, R. W. (1997). *The ISO 9000 Handbook*, Irwin Professional Publishing, Chicago.

26. Predpall, D. F. (1994). 'Developing Quality Improvement Processes in Consulting Engineering Firms', *Journal of Management in Engineering*, Vol. 10, No. 3, pp. 28-34.

2 .Ransom, W H. (1987) *Building Failures: Diagnosis and Avoidance*, E. & F. N. SPON, London.

8. Saarinen Jr., W., Hobel, M. A. (1990). 'Setting and Meeting Requirements for Quality', *Journal of Management in Engineering*, Vol. 6, No. 2, pp. 177-185.

29. Snedecor, G. W., and Cochran, W. G. (1971). *Statistical Methods*, The Iowa State University Press, Iowa, U. S. A.

30. Trainor, E. F. (1983). 'Comments on Quality Assurance Program Management', *Quality Assurance in the Building Community*, Proceedings of the National Conference.

3 . Turner, J. R. (1993). *The Handbook of Project-Based Management*, McGraw-Hill Book Company, London.

APPENDIX I

QUESTTIONAIRE

بسم الله الرحمن الرحيم

Ministry of Higher Education
King Fahd University of Petroleum & Minerals
COLLEGE OF ENVIRONMENTAL DESIGN
Dept. of Construction Engineering & Management

وزارة التعليم العالي
جامعة الملك فهد للبترول والمعادن
كلية تصاميم البيئة
قسم هندسة وإدارة التشييد

Dear Manager,

The purpose of this letter is to kindly invite you to participate in a study survey regarding Quality Management Practices in the Design Process in the Saudi Arabian construction industry.

The objective of the study is to evaluate the design service quality of the organizationsin the local construction industry by determining the prevalence of the related Quality Management Practices.

The results of this study can be a great help to your organization by providing you with a synopsis of the prevalent Quality Management Practices among the local organizations. The results can give you an idea of the quality of service provided by your organization as compared to the other organizations; and thus help you in marketing your strengths and developing areas of your service in which you feel your organization is lagging behind.

Please provide the needed information, requested in the enclosed questionnaire, as practiced by your organization. The information provided by you will be used only for the purpose of the study without mentioning the name of the organization. We realize that there are numerous demands on your time, however your involvement is a vital requisite for this study. We will be highly grateful if you could return the completed questionnaire to us on or before the 30th of September 1997 at any one of the addresses below.

We highly recommend you to obtain a copy of the results of this study, which will be sent to you upon your request. Please feel free to contact us, if you have any questions regarding this study, at the following details:

Dr. Abdulaziz A. Bubshait,
P.O.Box: 960, KFUPM,
Dhahran-31261
Tel:8603709 ; Fax:8604453

Engr. Gulam Farooq
P.O.Box: 1224, KFUPM,
Dhahran-31261
Tel:8606138 (R) ; Tel:8603275 (O)

Thank you for your anticipated cooperation.

Yours Sincerely,

Dr. Abdulaziz A. Bubshait
Associate Professor
Study Director

Engr. Gulam Farooq
Research Associate

QUESTIONNAIRE

Respondent's Title:

I. General Questions Regarding the Organization:

1	Type of Work Undertaken by the Organization	Percentage (%)
a	Building	
b	Engineering (highways, bridges, etc.)	
c	Industrial (power plants, refineries, etc.)	
d	Others (please specify): _____	
	Total	100

2	Annual Business Volume (Millions of Saudi Riyals)	
3	Number of Permanent Employees	
4	Number of Temporary Employees	
5	Average Contract Duration (months)	
6	Number of Years in Business	
7	Annual Profit Ratio	

II. Questions Regarding the Design Process (please indicate the extent of the following Quality Management Practices in your organization):

1-Always; 2-Mostly; 3-Sometimes; 4-Rarely; 5-Never

	QUALITY MANAGEMENT PRACTICES	Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
1	The organization has an established quality program.					
2	Organizational objectives and individual responsibilities for quality are clearly defined.					
3	Quality manual is present and is updated to reflect current quality policies and procedures.					
4	The organization has a specified design methodology.					

Questions 1 to 4 measure the **Organizational Quality Policy**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Organizational Quality Policy	

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
5	All design professionals in the organization are qualified and the organization keeps a record of their qualifications.					
6	All the design professionals in the organization follow a single design method/code.					

Questions 5 and 6 measure the **Designer Qualification**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Designer Qualification	

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
7	Employees are provided with on the job training.					
8	Short courses and seminars for employees are provided.					
9	The organization provides office library facilities.					

Questions 7 to 9 measure the **Employee Training and Education**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Employee Training and Education	

QUALITY MANAGEMENT PRACTICES		Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
10	The design process is planned.					
11	Design inputs are elaborated before preparation of design documents.					
12	Design interfaces are identified in the preliminary design.					

Questions 10 to 12 measure the **Design Planning**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	Importance Rating (1-10)
Design Planning	

QUALITY MANAGEMENT PRACTICES		Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
13	Design inputs are identified and transmitted in written form, thus defining responsibility.					
14	Design inputs are reviewed and agreed upon by the interfacing division early on in the design process.					

Questions 13 to 14 measure the **Design Inputs**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Design Inputs	

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
15	Work on a project is assigned to a single team.					
16	The preliminary design resolves all discrepancies related to structural and equipment interaction.					
17	The preliminary design allows for selection of major dimensions of the structures.					
18	Design activities (calculations, drawings, specifications, and others) are performed according to established procedures or standard templates.					
19	Documentation of investigations, assumptions, and computer calculations utilized for design activities is kept.					
20	Design documents specify important construction methods and data (special treatments, sequence of operations, applicable specifications, special equipment, and work methods).					

Questions 15 to 20 measure the **Design Process**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Design Process	

QUALITY MANAGEMENT PRACTICES		Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
21	Interface control is practiced and any activity affecting the design quality is identified in writing.					
22	Design information transmitted from one organization to another is documented and identified.					
23	Transmission of design information between organizations is done through the use of standard procedures or templates.					
24	Any verbally or informally transmitted information is promptly confirmed in writing.					

Questions 21 to 24 measure the **Interface Control**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	Importance Rating (1-10)
Interface Control	

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
25	Design review/verifications are made by persons other than those performing the particular design.					
26	Design calculations are reviewed and verified.					
27	Review/verification of design drafts and drawings.					
28	Review/verification of specifications and standards.					
29	Review/verification of design drawings.					
30	Review/verification of space allocation and capacity.					
31	Review/verification of aesthetics.					
32	Final project drawings and specifications are reviewed and any omissions corrected before being handed over to the construction contractor.					

Questions 25 to 32 measure the **Design Review**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area

Quality Management Area	**Importance Rating (1-10)**
Design Review	

QUALITY MANAGEMENT PRACTICES		Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
33	Any design changes affecting contractual requirements are made available in writing, and the client's and/or client's representative's approval obtained.					
34	Design changes are identified and documented for easy retrieval.					
35	Activities affected by design changes are identified and the concerned personnel duly notified.					

Questions 33 to 35 measure the **Design Changes**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Design Changes	

	QUALITY MANAGEMENT PRACTICES	Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
36	Subcontracted designers hired for designing special areas of the project are informed and selected according to the organization's quality program.					
37	The organization works closely with any subcontracted designer to ensure unity of design.					

Questions 36 to 37 measure the **Subcontractor Control**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	Importance Rating (1-10)
Subcontractor Control	

QUALITY MANAGEMENT PRACTICES		Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
38	All documents relating to the project are indexed and properly filed.					
39	All documents relating to the project are regularly updated.					
40	All documents relating to the project are easily available to the concerned personnel.					
41	Documents are revised and re-issued after practical number of changes have been issued.					

Questions 38 to 41 measure the **Document Control**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Document Control	

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
42	Ease of maintainability and/or replacement is kept in mind when specifying materials in design.					
43	Provisions are made in the design to provide easy accessibility for any future project maintenance.					

Questions 42 to 43 measure the **Design Maintainability**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Design Maintainability	

QUALITY MANAGEMENT PRACTICES		Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
44	There is a frequent use of CAD tools.					
45	Computer softwares utilized in the design process are selected based on their accuracy and checked for any errors.					

Questions 44 to 45 measure the **Computer Usage**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Computer Usage	

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
46	Roles of the project team members are defined through discussion with the client and/or client's representative.					
47	Working procedures and communication lines are defined through discussion with the client and/or client's representative.					
48	Project cost, schedule, and quality are defined through discussion with the client and/or client's representative.					
49	Contractual requirements and constraints are defined through discussion with the client and/or client's representative.					
50	Project requirements are defined through discussion with the client and/or client's representative.					
51	Methods of testing design correctness are defined through discussion with the client and/or client's representative.					
52	The complete project brief is developed through discussion with the client and/or client's representative.					

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
53	Space utilization and material appropriateness is defined through discussion with the client and/or client's representative.					
54	Methods for resolving design conflict are defined through discussion with the client and/or client's representative.					
55	Location drawings and physical models are made for review.					
56	The correctness of the scheme design with regard to the project brief is checked with the client and/or client's representative.					
57	Constructability of the detail design is checked with the client and/or client's representative, and the construction contractor.					
58	Specification classification is worked out with the client and/or client's representative, and the construction contractor.					
59	Contractual details for construction are worked out with the client and/or client's representative, and the construction contractor.					

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
60	Requirements for temporary works are worked out with the client and/or client's representative, and the construction contractor.					
61	Degree of accuracy of the drawings and the detail required is established with the client and/or client's representative, and the construction contractor.					
62	Practicality of the design drawings is verified with the client and/or client's representative, and the construction contractor.					
63	Material and workmanship requirements are established with the client and/or client's representative, and the construction contractor.					
64	Appropriate specifications and their details are worked out with the client and/or client's representative, and the construction contractor.					
65	Procedures for communicating design inconsistencies and their correction is established with the client and/or client's representative, and the construction contractor.					

QUALITY MANAGEMENT PRACTICES		Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
66	There is regular review of the work performed by the construction contractor to help in any possible design changes required by the client and/or to improve project cost, schedule, and quality.					

Questions 46 to 66 measure the **Working Relationship**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Working Relationship	

	QUALITY MANAGEMENT PRACTICES	Always 1	Mostly 2	Some-times 3	Rarely 4	Never 5
67	The organization keeps a record of all quality activities of the project with the results of any design verifications noted.					
68	After the end of the project, a study of the significant project characteristics is made for future reference.					
69	An evaluation by the client regarding the services provided is requested at the end of each project.					
70	An evaluation by the construction contractor regarding the working relationship is requested at the end of each project.					

Questions 67 to 70 measure the **Performance Quality Audit**. On a scale of 1 to 10, where one is the lowest possible rating and ten the highest; please indicate the importance you feel for this Quality Management Area.

Quality Management Area	**Importance Rating (1-10)**
Performance Quality Audit	

QUALITY MANAGEMENT PRACTICES		Always	Mostly	Some-times	Rarely	Never
		1	2	3	4	5
71	Others (please specify; your suggestions and comments will be a great help in this study)					

APPENDIX II

NAMES AND ADDRESSES OF THE LOCAL A/E CONSULTING ORGANIZATIONS

S. No.	Organization	Address	City	Code	Phone	Fax
1	Abdulaziz Al-Othman and Partners Engineering Consultancy	P. O. Box - 1445	Al-Khobar	31952	8944563	8944578
2	Abdulla Al Moaibed Engineering Office	P. O. Box - 61	Ad-Dhahran	31932	8951400	8647965
3	Abdullah Al-Juaib Engineering Office	P. O. Box - 9437	Ad-Dammam	31413	8421492	8428360
4	Abdulrahman Al Al-Shaikh Mubarak Office	P. O. Box - 1673	Al-Khobar	31952	8951802	8946573
5	Abdulrahman Mohammad Al-Shuhail Engineering Consultants	P. O. Box - 6047	Ad-Dammam	31442	8330108	8340607
6	Ad-Dammam Engineering Centre	P. O. Box - 4195	Ad-Dammam	31491	8333700	8340398
7	Ad-Dossary Engineering Office	P. O. Box - 4024	Ad-Dammam	31491		
8	Adnan Bassam Office	P. O. Box - 24	Al-Khobar	31952	8980071	8993282
9	Ahmed Al Mousa Engineering Consultant	P. O. Box - 7266	Ad-Dammam	31462	8348883	8343944
10	Ahmed Omar Radi Architect	P. O. Box - 1841	Ad-Dammam	31441	8338544	8338538
11	Ahsan Al-Abbab Engineering Office	P. O. Box -	Al-Khobar	31952	8991288	8648917
12	Aiman Malaikah Engineering and Topography Consultaning Office	P. O. Box - 3472	Al-Khobar	31952	8941069	8649937
13	Al-Ahmadi Consulting Engineer	P. O. Box -	Al-Jubail	31961	3613736	3615150
14	Al-Amir Office for Engineering Studies	P. O. Box - 5177	Ad-Dammam	31422	8349478	
15	Al-Buraiki Engineering Office	P. O. Box - 234	Al-Qateef	31911	8553309	8553321
16	Al-Dahli Engineering Services	P. O. Box - 3685	Ad-Dammam	31481	8322121	8330260
17	Al-Fawzan Engineering Office	P. O. Box - 3908	Al-Khobar	31952	8649297	8952148
18	Al-Ghannam Engineering Office	P. O. Box - 716	Al-Jubail	31951	3611994	3611498
19	Al-Haddad Engineering Consultants	P. O. Box - 5635	Ad-Dammam	31432	8541609	8347253
20	Al-Hajlass Engineering Office	P. O. Box - 784	Al-Qateef	31911	8556697	8559243
21	Al-Hamdan Consulting Office	P. O. Box - 2474	Al-Khobar	31952	8983641	8946872
22	Al-Hamed Technical and Engineering Services	P. O. Box - 6022	Ad-Dammam	31442	8267495	
23	Al-Hassan Engineering Consultancy	P. O. Box - 8943	Ad-Dammam	31492	8345059	8343623
24	Al-Hoty-Stanger Limited	P. O. Box - 1122	Al-Khobar	31852	8980958	8981466
25	Al-Ibrahim Engineering and Surveying Office	P. O. Box -	Al-Awamia	31911	8520948	8520948
26	Al-Ibrahim Engineering Office	P. O. Box - 5091	Ad-Dammam	31422	8331259	
27	Al-Id Engineering Consultants	P. O. Box - 5967	Ad-Dammam	31432	8332266	8324341
28	Al-Khobar Engineering and Consulting Center	P. O. Box - 888	Al-Khobar	31952	8577778	8577906

S. No.	Organization	Address	City	Code	Phone	Fax
29	Al-Mald Engineering Office	P. O. Box - 426	Hafr Al-Batin	31911	7221836	
30	Al-Maldh Engineering Consultancy	P. O. Box - 3278	Ad-Dammam	31471	8335170	8336009
31	Al-Marhoon Engineering and Consulting Office	P. O. Box - 1934	Ad-Dammam	31441	8422320	
32	Al-Momin Engineering Office	P. O. Box - 2309	Al-Khobar	31952		
33	Al-Mustafa Engineering Office	P. O. Box - 407	Al-Qateef	31911	8559523	8559515
34	Al-Nafea Engineering Office	P. O. Box - 550	Al-Khobar	31952	8945321	8952936
35	Al-Obaidli Architectural and Design Office	P. O. Box - 5816	Ad-Dammam	31432	8336000	8575647
36	Al-Ojairi Designing Center	P. O. Box - 9827	Ad-Dammam	31423	8333305	8326047
37	Al-Osaimi Engineering Office	P. O. Box - 1736	Al-Khobar	31952	8573668	8573144
38	Al-Othman Center for Architectural and Engineering Design	P. O. Box - 518	Ad-Dammam	31421	8951818	8640758
39	Al-Othman Consultants	P. O. Box -	Al-Khobar	31952	8951717	8640758
40	Al-Qatari Consultants	P. O. Box - 570	Al-Qateef	31911	8540961	8540641
41	Al-Rabdi and Al-Baldali Engineering Consultancy and Services	P. O. Box - 4138	Al-Khobar	31952	8990095	8993430
42	Al-Rabdi Engineering Consultancy	P. O. Box - 4138	Al-Khobar	31952	8992202	8993430
43	Al-Royah Architectural Designs Office	P. O. Box - 4018	Al-Khobar	31952	8944936	8987404
44	Al-Safi Engineering Office	P. O. Box - 6790	Ad-Dammam	31542	8333302	8333302
45	Al-Sharq Engineering Office	P. O. Box - 806	Al-Khobar	31952	8983736	8945588
46	Al-Sindh Engineering Studies Office	P. O. Box - 436	Al-Khobar	31952	8644578	8644578
47	Al-Suhaimi Design Office	P. O. Box - 161	Ad-Dammam	31411	8264243	8265343
48	Al-Sumait Engineering Services	P. O. Box - 2763	Al-Khobar	31952	8575714	
49	Al-Uwaid Engineering Office	P. O. Box -	Al-Khobar	31952	8985619	8945841
50	Al-Wakeel Engineering Office	P. O. Box -	Al-Khobar	31952	8940093	8946961
51	Al-Yousuf Civil Engineering Office	P. O. Box - 4519	Ad-Dammam	31412	8428450	8425180
52	Al-Zarki for Civil Engineering	P. O. Box - 2203	Ad-Dammam	31451	8272675	8262471
53	Al-Zawad Engineering Office	P. O. Box - 5430	Ad-Dammam	31422	8422348	
54	Alawami Planners and Consultants	P. O. Box - 88	Al-Qateef	31911	8551006	8553768
55	Ali Khudair Al-Harbi and Ahmad Omar Radhi Engineering Consultancy	P. O. Box - 684	Al-Khobar	31952	8951777	8942122
56	Arab Surveying Center	P. O. Box -	Ad-Dammam	31488	8348305	8320590

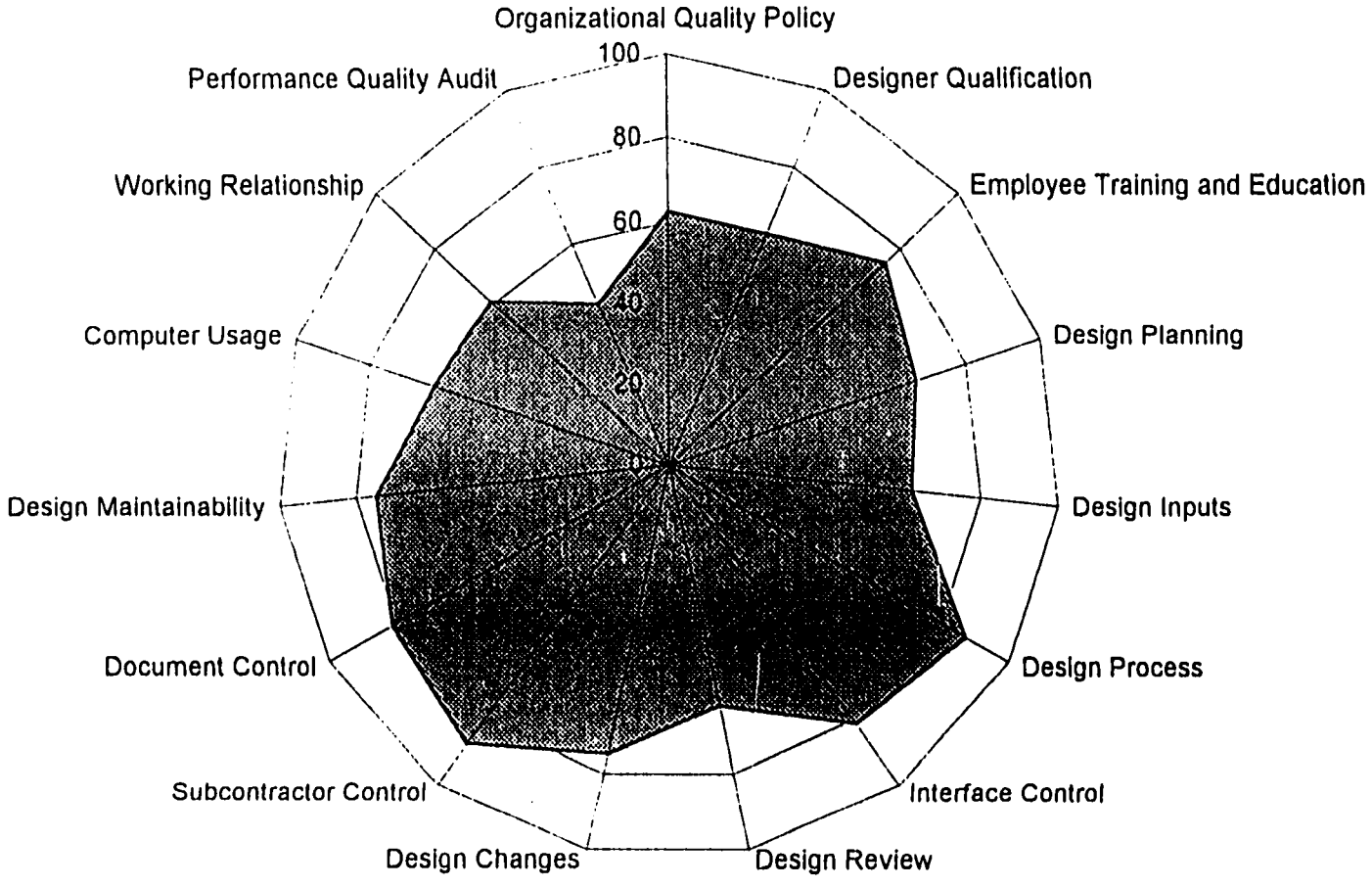
S. No.	Organization	Address	City	Code	Phone	Fax
57	Arabesque Consulting Engineers	P. O. Box - 3513	Al-Khobar	31952	8940320	8950452
58	Arabian Consulting Engineering Centre	P. O. Box - 3790	Al-Khobar	31952	8595555	8574317
59	Arabian Geophysical and Surveying Company (ARCAS)	P. O. Box - 535	Al-Khobar	31952	8577472	8579042
60	Architectural and Engineering Services Technical Office	P. O. Box - 1178	Ad-Dammam	31431	8266125	8266684
61	ASAS for Engineering Designs and Technical Enterprises	P. O. Box - 6579	Ad-Dammam	31452	8271922	8269589
62	Ayadh Al-Fadhli Engineering Office	P. O. Box - 1306	Al-Khobar	31952	8945588	8945588
63	Ba-AlHaddad Engineering Office	P. O. Box - 21	Al-Khobar	31952	8642186	
64	Bakr Al-Haajri for Architectural Engineering	P. O. Box - 2455	Al-Khobar	31952	8982990	8985255
65	Bu-Kannan Engineering Office	P. O. Box - 5378	Ad-Dammam	31422	8348701	8348591
66	Consulting and Design Engineering	P. O. Box - 2502	Al-Khobar	31952	8951832	8986312
67	Contel Federal Systems Company	P. O. Box - 888	Al-Khobar	31952	8577910	8577906
68	Daka Surveying Saudi Arabia Limited	P. O. Box - 4835	Ad-Dammam	31412	8262214	
69	Dar Al Riyadh Consultants	P. O. Box -	Ath-Thuqbah	31952	8919584	8911656
70	Dar Al-Mustafa Civil Engineering	P. O. Box - 100	Al-Qateef	31911		
71	Dewan Design and Art	P. O. Box - 30	Ad-Dammam	31411		
72	Engineer Abdullah Aba Al-Khalil Office	P. O. Box - 417	Ad-Dhahran	31932	8981844	8980828
73	Engineer Abdulrahman Yousif Abdulrahman Al-Wakeel Office	P. O Box -	Al-Khobar	31952	8980724	8946961
74	Engineer Fawaz Omar Radhi Engineering Consultancy	P. O. Box - 1075	Al-Khobar	31942	8940724	8986560
75	Engineer Fazil Bu-Khamsin Civil Engineering Office	P. O. Box - 3148	Ad-Dammam	31471	8332144	
76	Engineer Khalid Hamad Al-Eidhi Civil Engineering Office	P. O. Box - 426	Ad-Dhahran	31932	8942138	8987079
77	Engineer Mohammad Ahmed Al Urshaid	P. O. Box - 707	Al-Khobar	31952	8575563	8571262
78	Engineer Mohammad Omar Al-Amoudi Office	P. O. Box - 1445	Al-Khobar	31952	8953923	8987079
79	Engineer Riadh Al-Hamoud Engineering Office	P. O. Box - 3322	Ad-Dammam	31471		8942204
80	Engineer Sameer Abdulaziz Al-Muhaish Engineering Office	P. O. Box - 5217	Ad-Dammam	31422	8344449	8333880
81	Engineer Sulaiman Al-Hamid Office	P. O. Box - 1745	Ad-Dammam	31441	8263596	
82	Engineering and Technical Services Office (Consulting Engineers)	P. O. Box - 2146	Ad-Dammam	31451	8262512	8275114
83	Engineering Consulting Office	P. O. Box - 1736	Al-Khobar	31952	8573664	8573144
84	Engineering Design and Supervision Firm	P. O. Box - 3168	Al-Khobar	31952	8943022	8649377

S. No.	Organization	Address	City	Code	Phone	Fax
85	Fareed Mohammad Zedan Consultant Office	P. O. Box - 88	Ad-Dhahran	31932	8641082	8992960
86	Farid for Surveying Services	P. O. Box - 1843	Al-Khobar	31952	8641064	8954618
87	Furgo-Suhaimi Limited	P. O. Box - 2165	Ad-Dammam	31451	8574200	8572035
88	Ghassan's Designing Studio	P. O. Box - 7389	Ad-Dammam	31462	8335795	8337186
89	Gulf Engineering Consulting Office	P. O. Box - 684	Al-Khobar	31952	8955036	8949015
90	Gulf Group Consult	P. O. Box - 2930	Ad-Dammam	31461	8335783	8340607
91	Hadi Worlwide/International Company Limited	P. O. Box - 822	Ad-Dammam	31421	8269582	8986312
92	Hajr Engineering Design Office	P. O. Box - 1324	Ad-Dammam	31431	8326370	8326370
93	Harco Arabia Cathodic Protection Company Limited	P. O. Box - 444	Ad-Dhahran	31932	8570554	8570245
94	Hassan Mazayel Engineering Office	P. O. Box - 337	Sehat	31972	8500013	8380096
95	Hassan Mehdi Al-Khaldaf Trading Services Establishment	P. O. Box -	Ad-Dammam	31478	8390226	
96	Hisham Ahmad Al-Rais Office	P. O. Box - 742	Ad-Dammam	31421	8339473	8339853
97	House of Engineering Expertise	P. O. Box -	Al-Khobar	31952	8990110	8647858
98	Jadawel Civil Engineering Office	P. O. Box - 6836	Ad-Dammam	31452	8333431	8333431
99	Jassim Al Qu Ahmed Office/Firm	P. O. Box - 189	Al-Qateef	31911	8541979	8541979
100	Joannou and Paraskevaides Overseas Limited	P. O. Box - 720	Al-Khobar	31952	8579096	8572308
101	Jubail Consult	P. O. Box - 769	Al-Jubail	31951	3614908	3610883
102	Khalid Saud Al-Saleh Engineering Office	P. O. Box - 81	Al-Khobar	31952	8949565	8648127
103	Ma'eer Engineering Design	P. O. Box - 9860	Ad-Dammam	31423	8433359	
104	Mahmood Marwan Al-Dhahrab Engineering Office	P. O. Box - 497	Hafr Al-Batin	31991	7223123	
105	Majed and Mohammad Al-Arji for Trade and	P. O. Box - 168	Ad-Dammam	31411	8432200	8432885
106	Mohammad Ba-Agl Engineering Office	P. O. Box - 6790	Ad-Dammam	31452	8344436	8333302
107	Nafidh Mustafa Al-Jandi Engineering Consultancy	P. O. Box - 2944	Al-Khobar	31952	8987152	
108	Omar Bashnaaq Engineering Office	P. O. Box - 811	Ad-Dammam	31421	8321616	
109	PI Consult	P. O. Box - 3773	Al-Khobar	31952	8982967	8952138
110	Rashid Geotechnical and Materials Engineers	P. O. Box - 2870	Al-Khobar	31952	8982240	
111	Riadh Abdulkareem Al Ibrahim Civil Engineering Office	P. O. Box - 876	Al-Qateef	31911	8559415	8559415
112	Saad Saleh Al-Hawar Engineering Office	P. O. Box - 2378	Ad-Dammam	31451	8526946	8416165

S. No.	Organization	Address	City	Code	Phone	Fax
113	Saber for Architechtural Studies and Design	P. O. Box - 616	Ad-Dammam	31421	8276226	8576394
114	Salah Al Theeb Engineering Office	P. O. Box - 9319	Ad-Dammam	31413	8433210	8348660
115	Salah Mohammad Sulaiman Engineering Office	P. O. Box - 2856	Al-Khobar	31952	8949866	8428360
116	Saud Abdulaziz Abdulmaghni Surveying Office	P. O. Box - 4016	Ad-Dammam	31491	8428571	8427513
117	Saud Kanoo Engineering Office	P. O. Box - 37	Ad-Dammam	31411	8323011	8345369
118	Saudi CAD Engineering Services	P. O. Box - 316	Ad-Dhahran	31932		8946364
119	Saudi Condreco Limited	P. O. Box - 693	Ad-Dammam	31421	8578874	8579845
120	Saudi Consolidated Engineering Company (Khatib & Alami)	P. O. Box - 1713	Al-Khobar	31952	8946816	8942341
121	Saudi Consulting and Design Office	P. O. Box - 2017	Al-Khobar	31952	8949001	8947593
122	Saudi Consulting Service	P. O. Box - 1293	Ad-Dammam	31431	8955004	8951722
123	Saudi Covy	P. O. Box -	Ad-Dammam		8344210	8341664
124	Saudi Designers Engineering Consultants	P. O. Box - 7953	Ad-Dammam	31472	8346778	8326594
125	Saudi Engineering Group International	P. O. Box - 1835	Al-Khobar	31952	8644558	8574435
126	Saudi Engineering International Group	P. O. Box - 5289	Ad-Dammam	31952	8328822	8335572
127	Saudi Technologists Consulting Engineers	P. O. Box - 1323	Ad-Dammam	31431	8940325	8647930
128	Sir Bruce White, Wolfe Barry and Partners	P. O. Box - 3020	Ad-Dammam	31471	8332691	
129	Sooter, Sooter, and Assam Abdulghani Engineering Consultancy	P. O. Box - 3422	Ad-Dammam	31471	8268565	8276083
130	Suhail Yousif Al-Ali Architectural Engineering Office	P. O. Box - 8544	Ad-Dammam	31492	8945370	8945370
131	Tamimi Engineering Office	P. O. Box -	Ad-Dammam	31451	8333222	8331005
132	Tariq Al-Yafi Engineering Consultancy	P. O. Box - 9448	Ad-Dammam	31413	8346479	8346479
133	Tariq Hajj Architects	P. O. Box - 64	Al-Khobar	31952	8641844	8987163
134	Technical Engineering Office	P. O. Box - 6858	Ad-Dammam	31452	8345310	
135	Technical Studies Bureau International	P. O. Box - 2885	Al-Khobar	31952	8940764	8946362
136	Western Engineering Office	P. O. Box - 3974	Ad-Dammam	31481	8339230	
137	Western Geophysical Company	P. O. Box - 1928	Al-Khobar	31952	8640231	8643253
138	Zamil and Tarbag Consulting Engineers	P. O. Box - 981	Al-Khobar	31952	8570044	8913868
139	Zia Al-Omair Architectural and Design Office	P. O. Box - 1414	Al-Khobar	31952	8954374	8954374
140	Zuhair Fayez-Association Architecturural and Engineering	P. O. Box - 141	Ad-Dhahran	31932	8644415	8955089

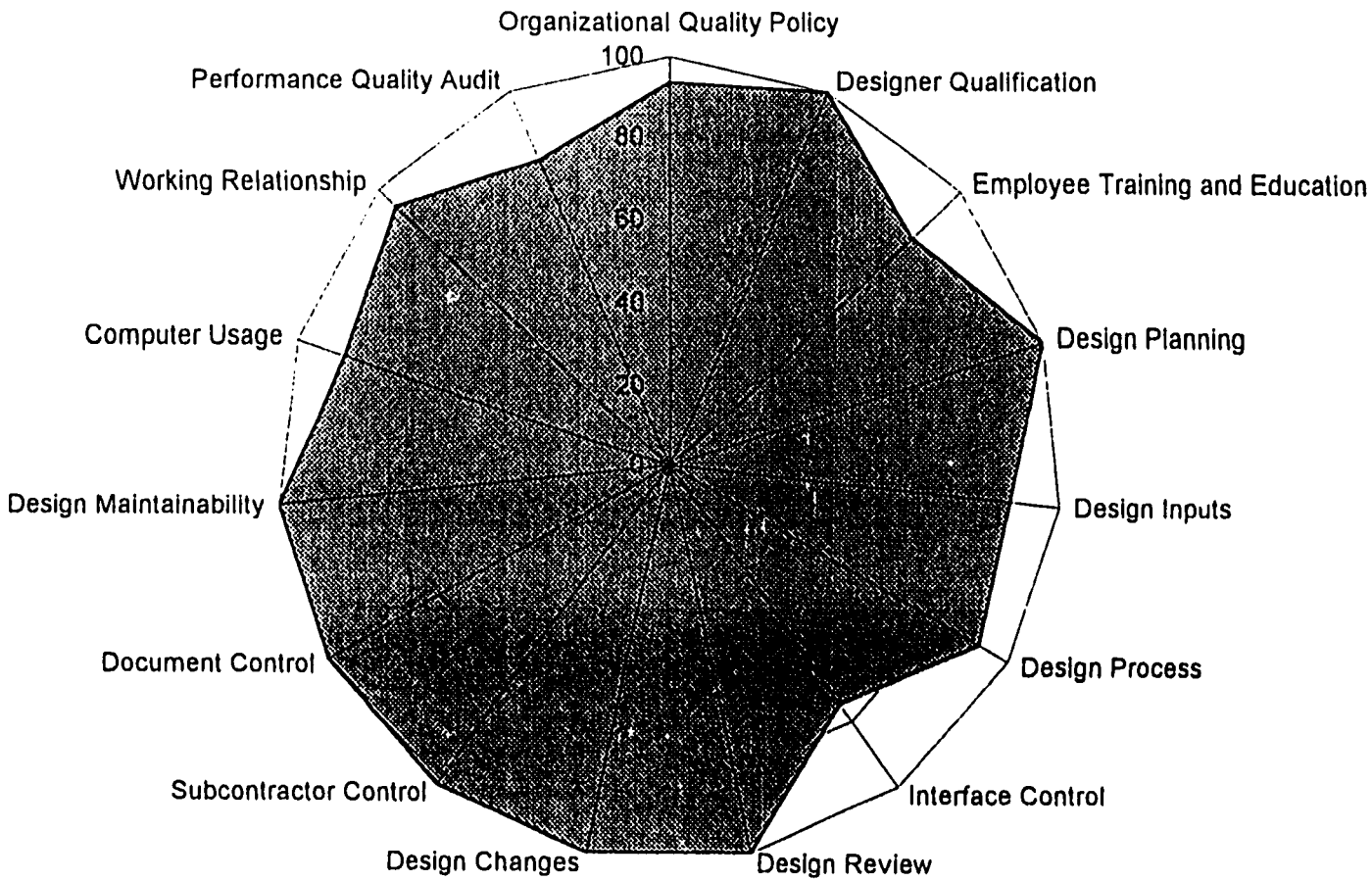
APPENDIX III

INDIVIDUAL SERVICE QUALITY AREAS OF THE RESPONDENT ORGANIZATIONS



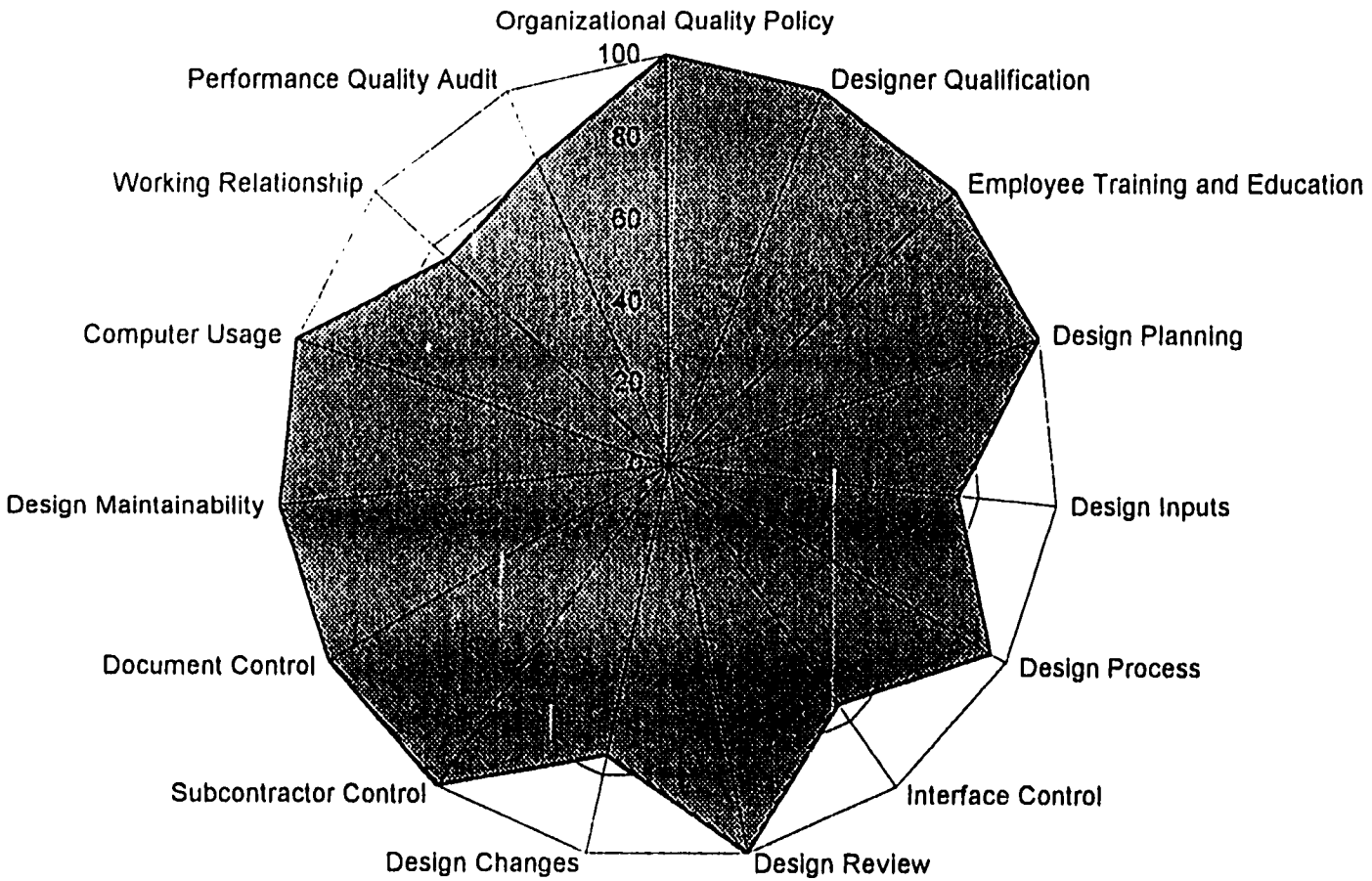
Service Quality Area = 69.74%

Service Quality Area of Organization 01



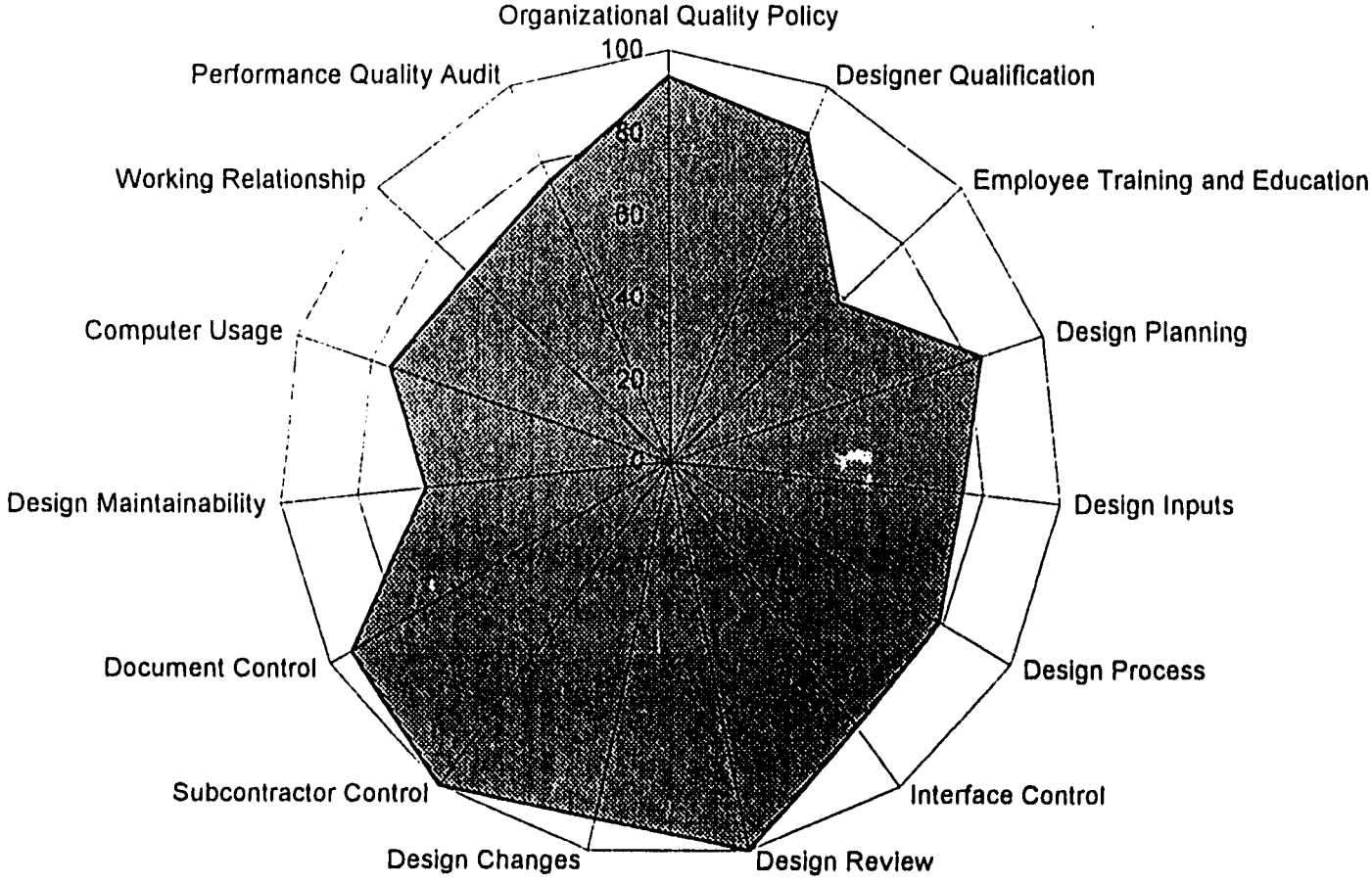
Service Quality Area = 92.94%

Service Quality Area of Organization 02



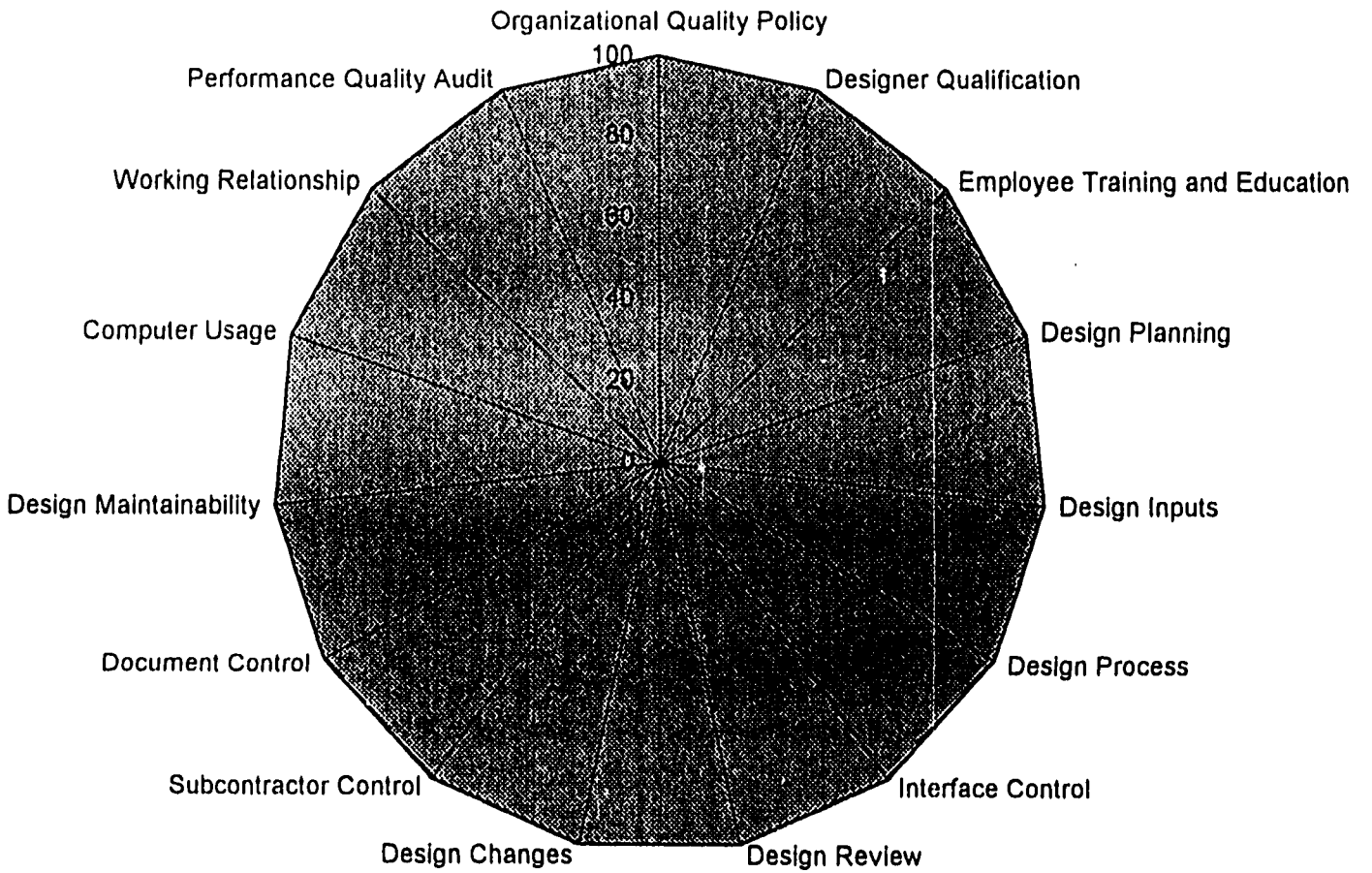
Service Quality Area = 91.81%

Service Quality Area of Organization 03



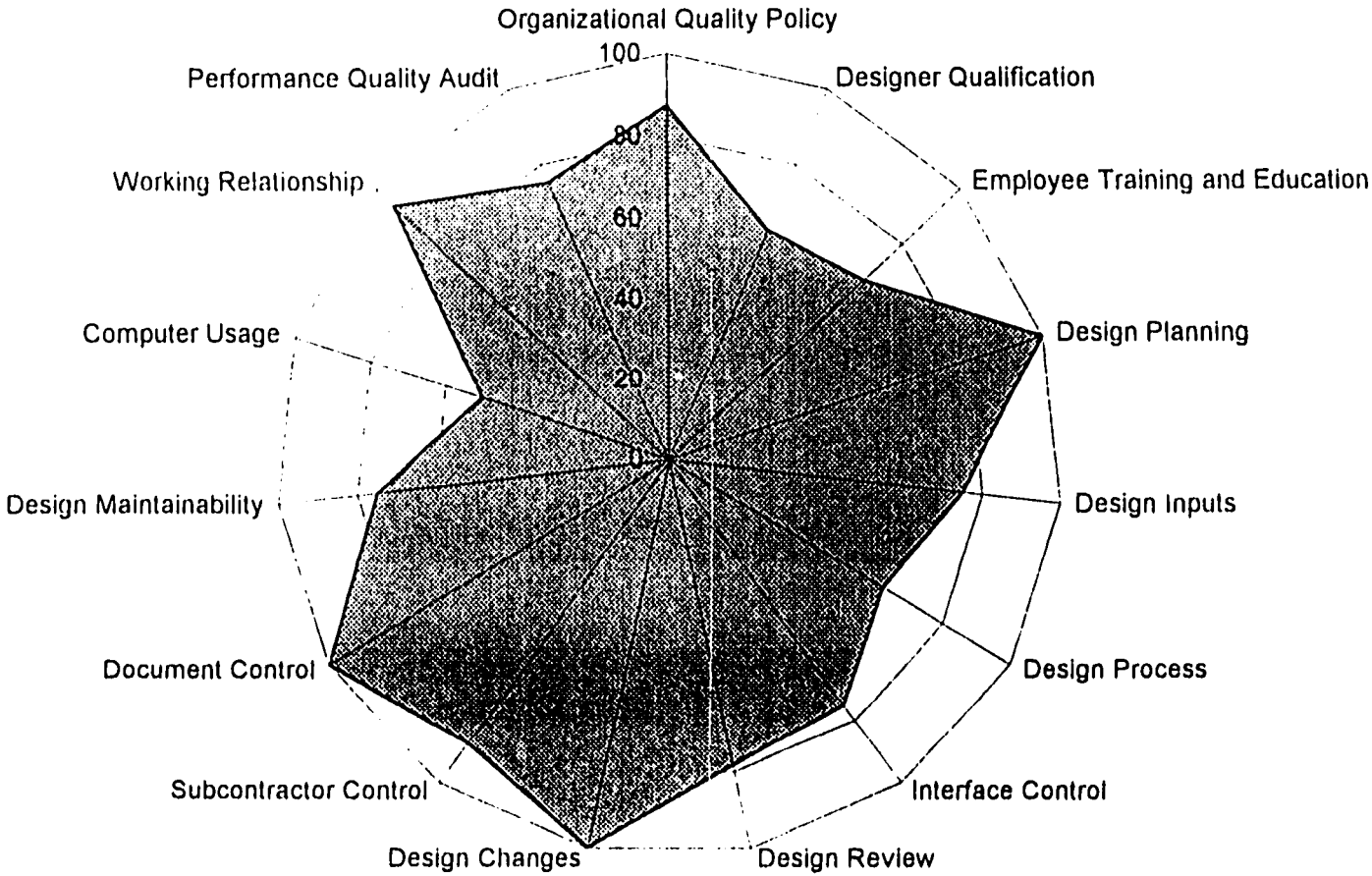
Service Quality Area = 81.69%

Service Quality Area of Organization 04



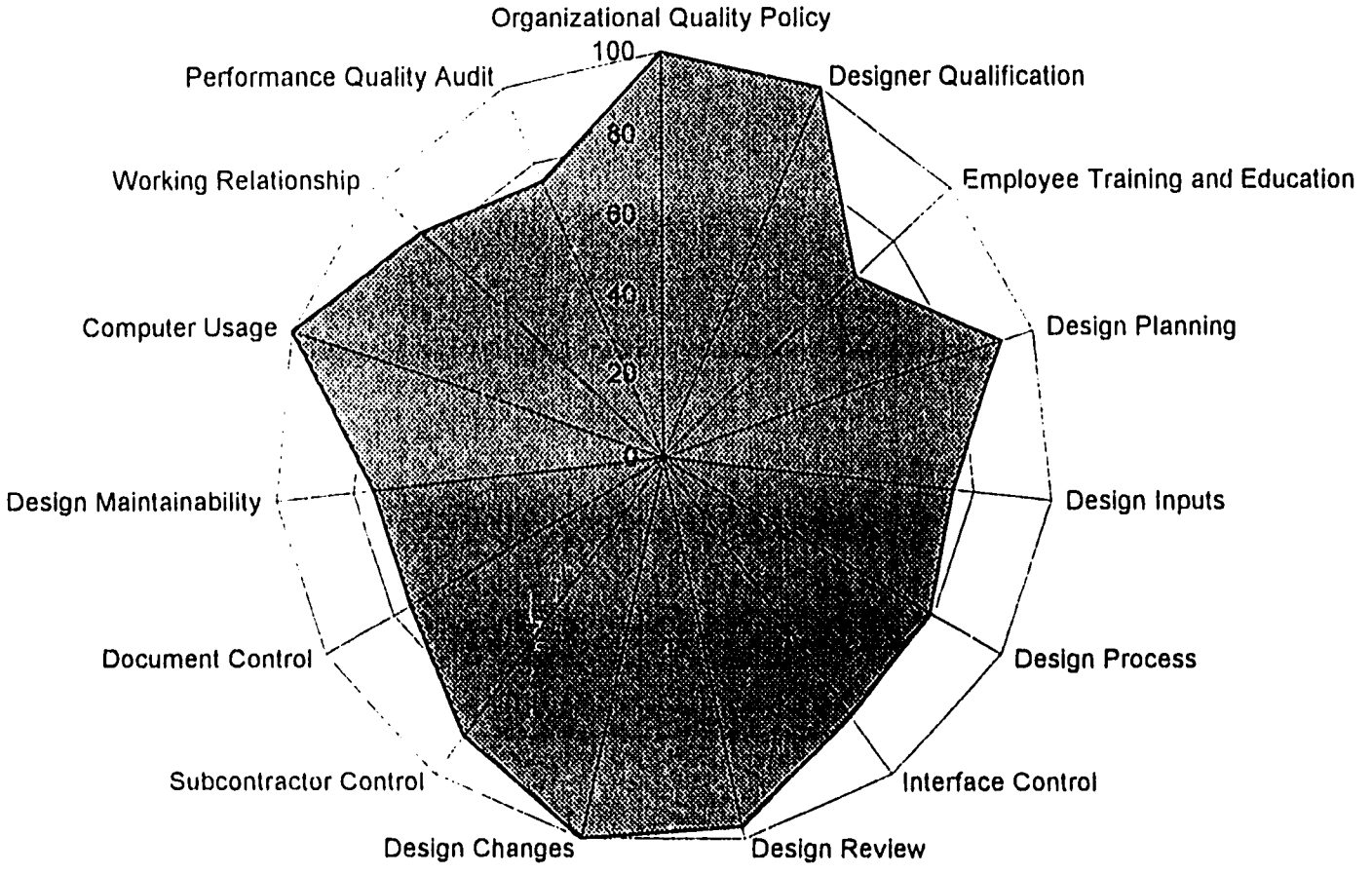
Service Quality Area = 100.00%

Service Quality Area of Organization 05



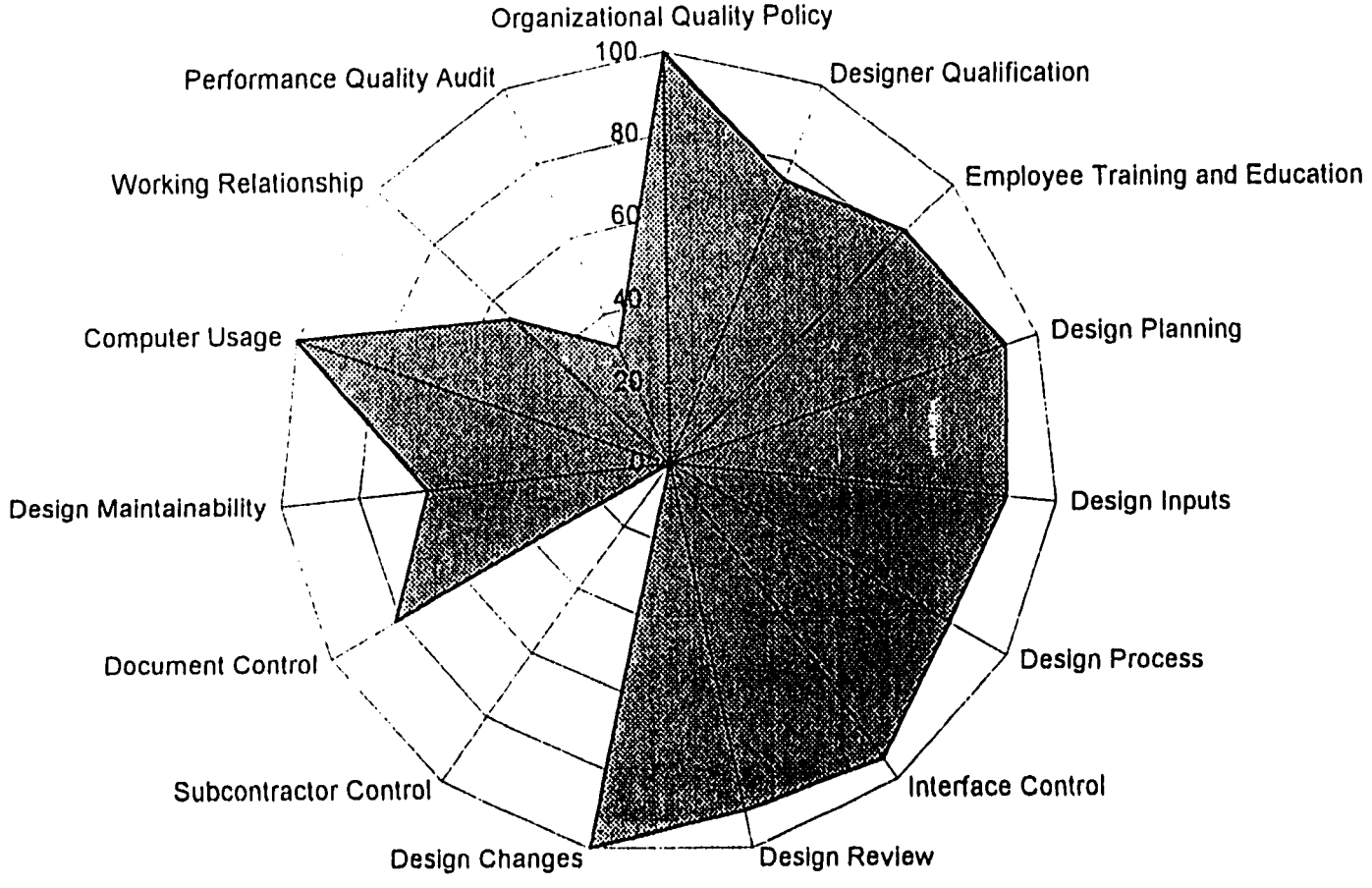
Service Quality Area = 79.26%

Service Quality Area of Organization 06



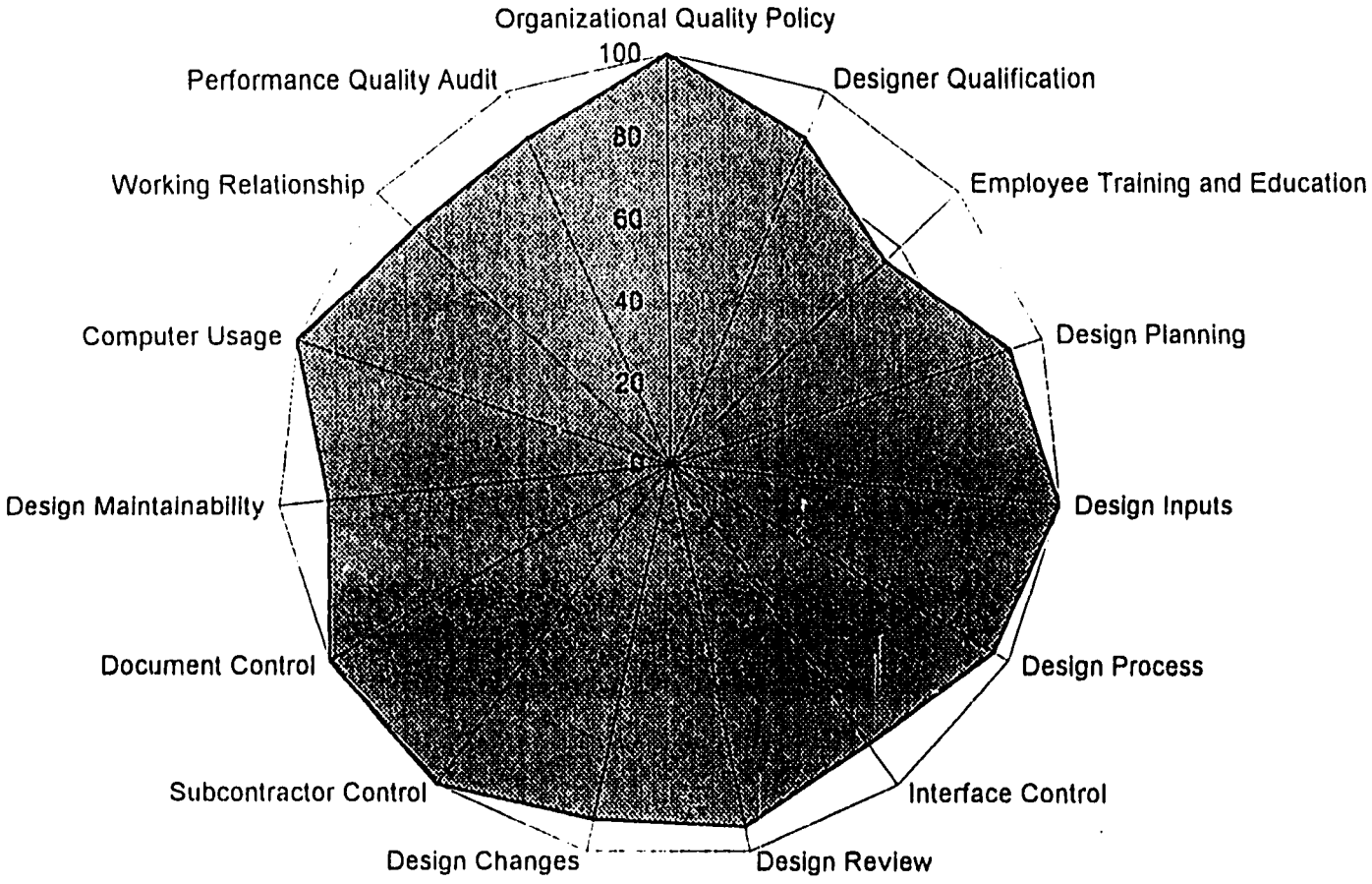
Service Quality Area = 85.76%

Service Quality Area of Organization 07



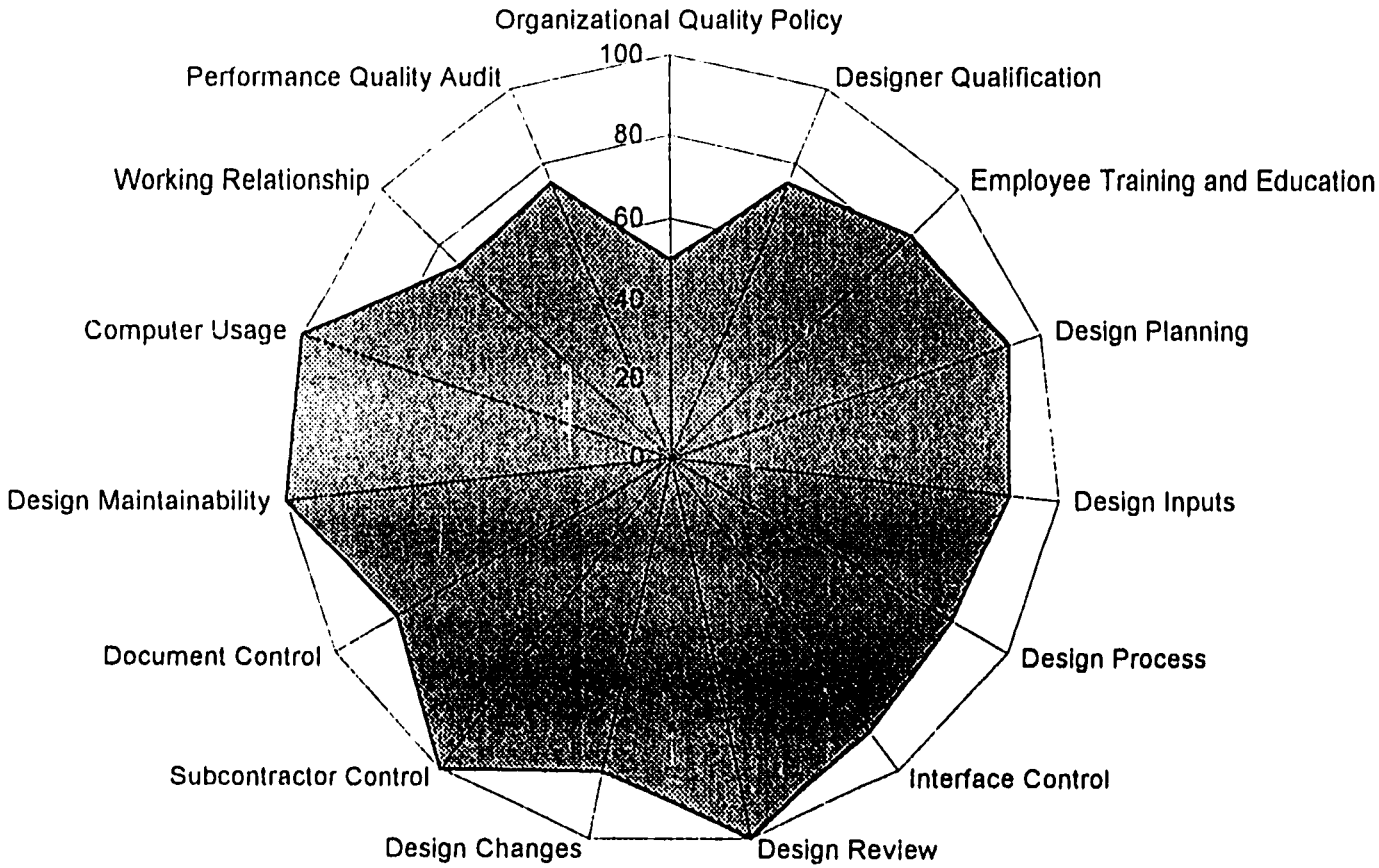
Service Quality Area = 75.59%

Service Quality Area of Organization 08



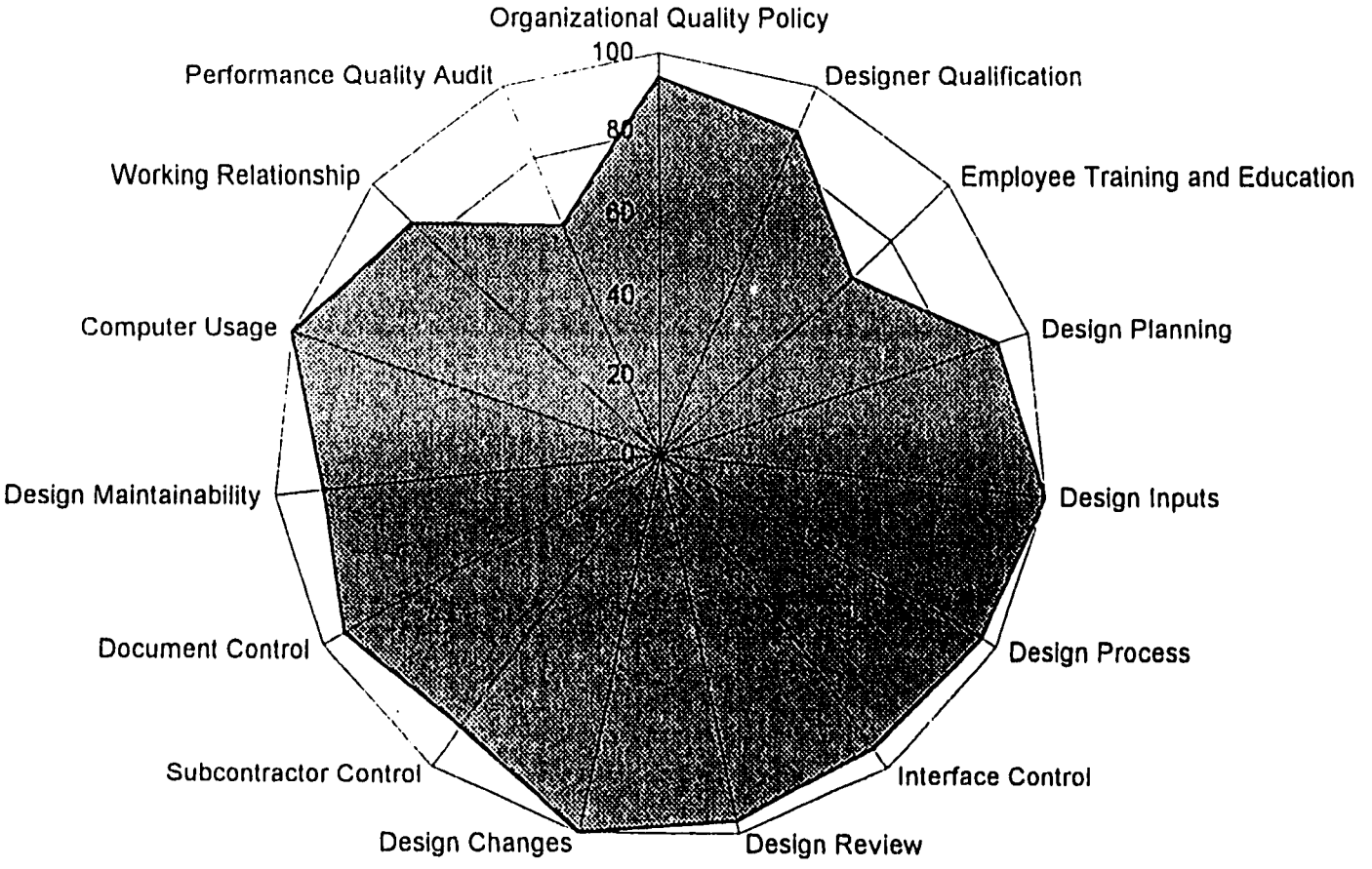
Service Quality Area =92.32%

Service Quality Area of Organization 09



Service Quality Area = 84.70%

Service Quality Area of Organization 10

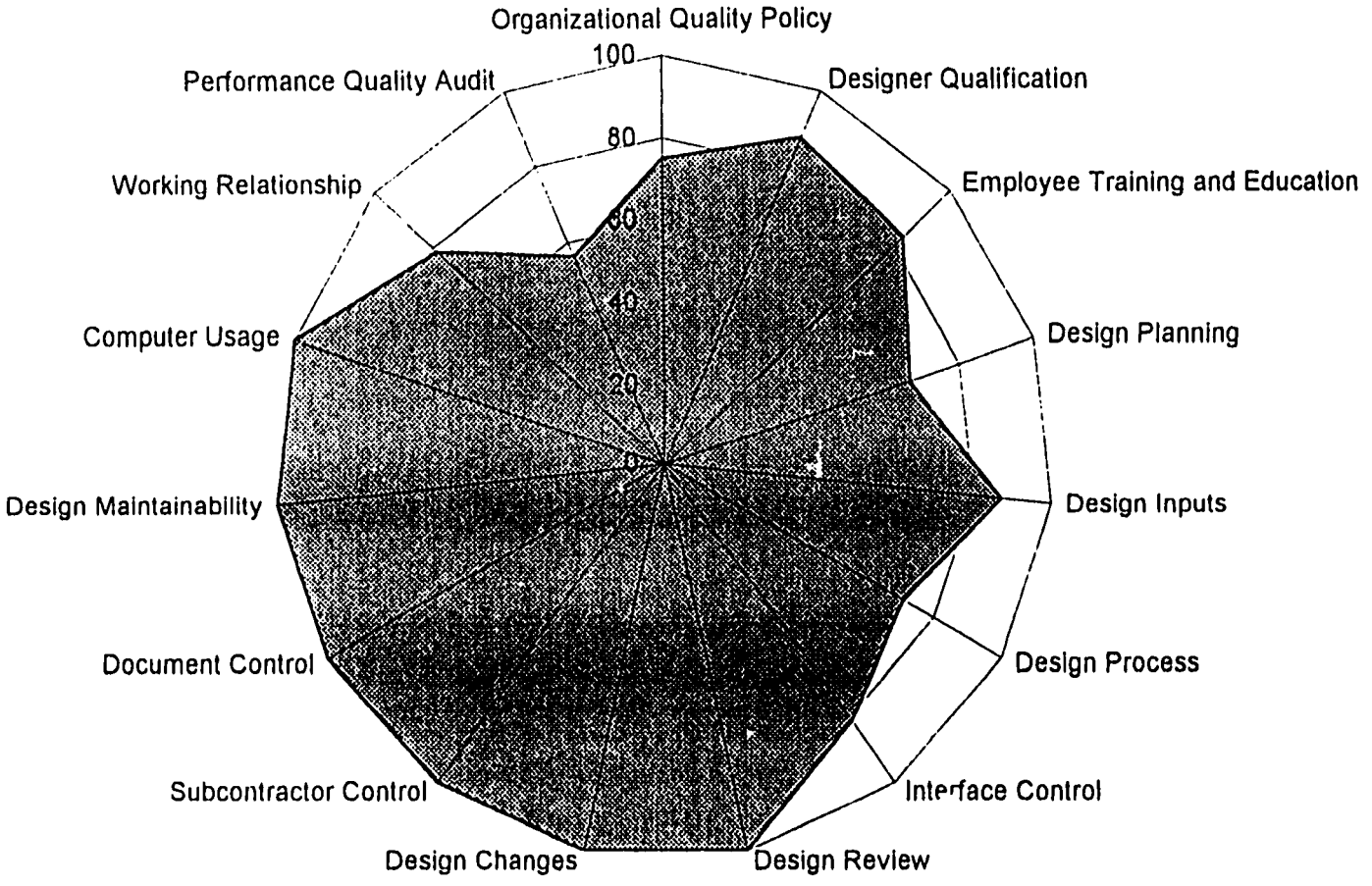


Service Quality Area = 89.57%

Service Quality Area of Oragnization 11

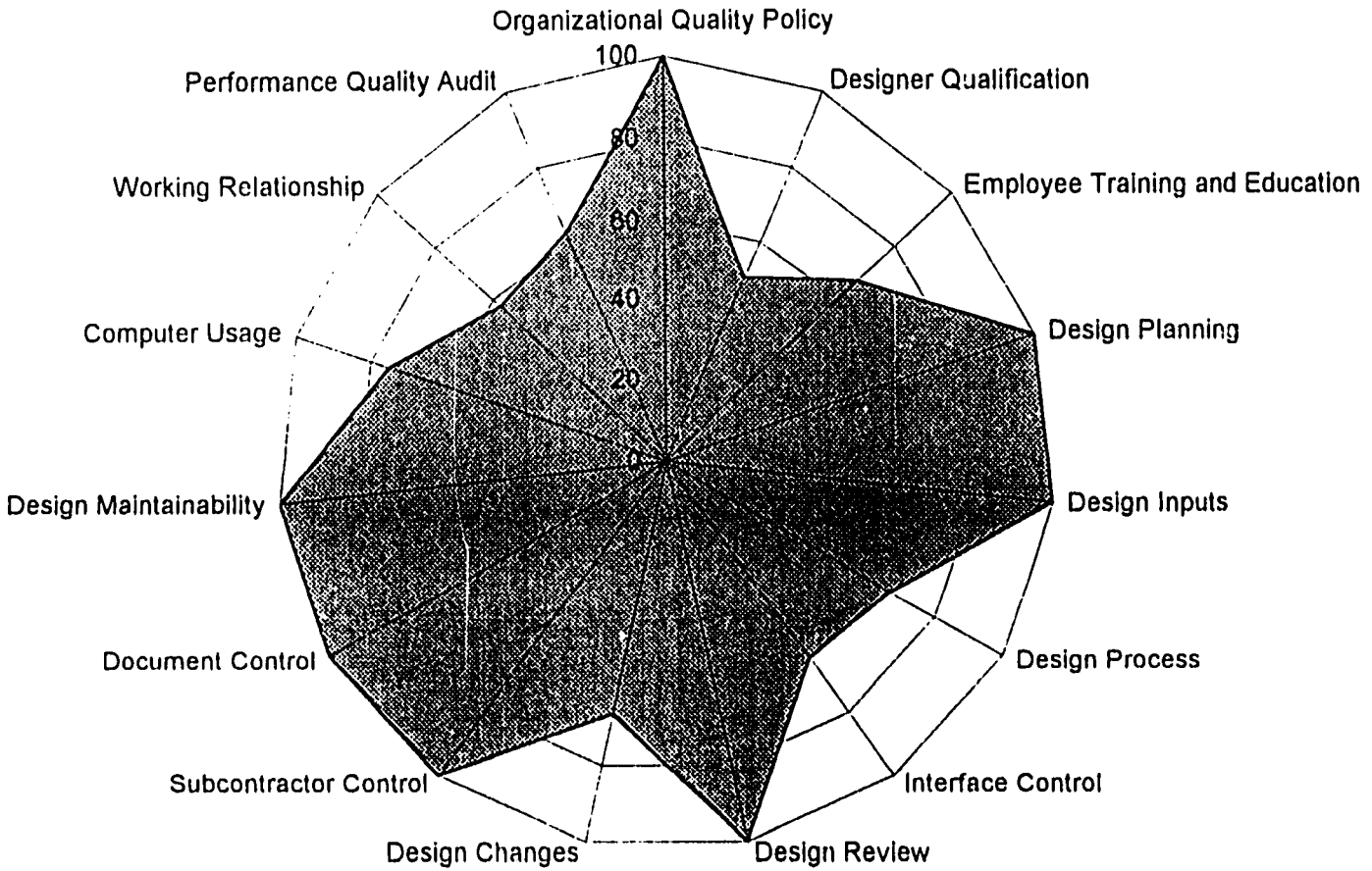
Service Quality Area = 72.62%

Service Quality Area of Organization 12



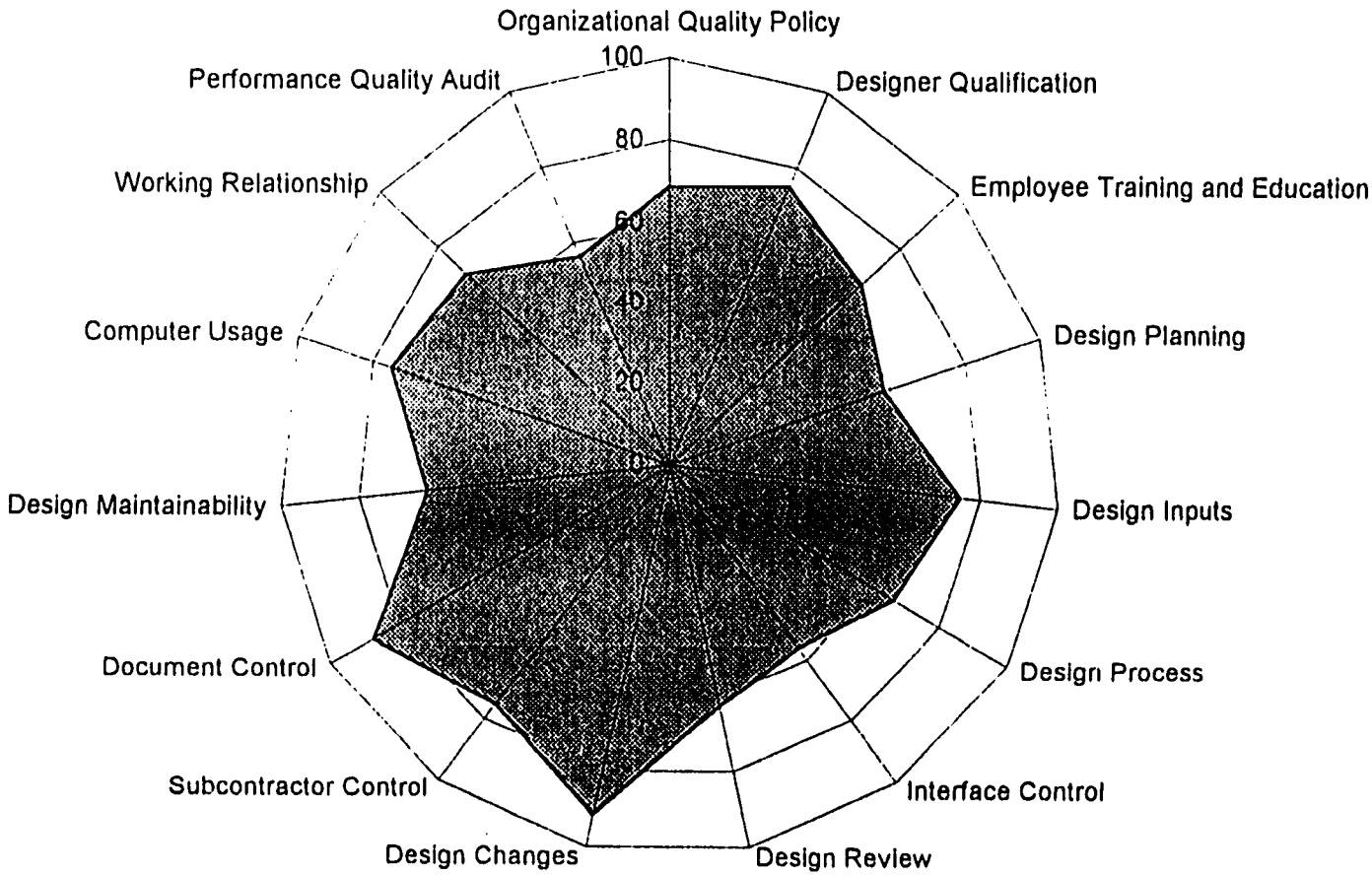
Service Quality Area = 85.79%

Service Quality Area of Organziation 13



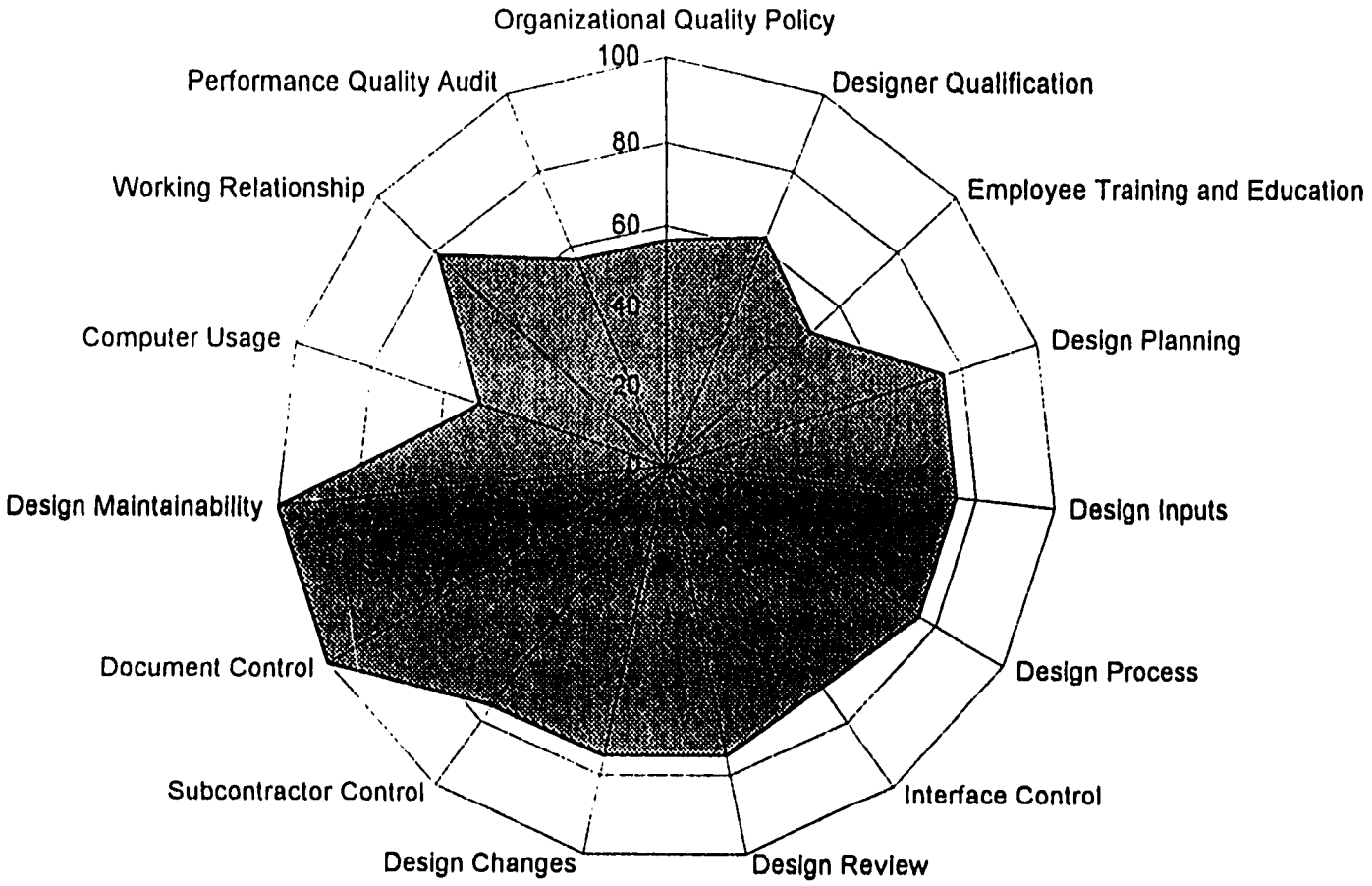
Service Quality Area = 80.48%

Service Quality Area of Organization 14



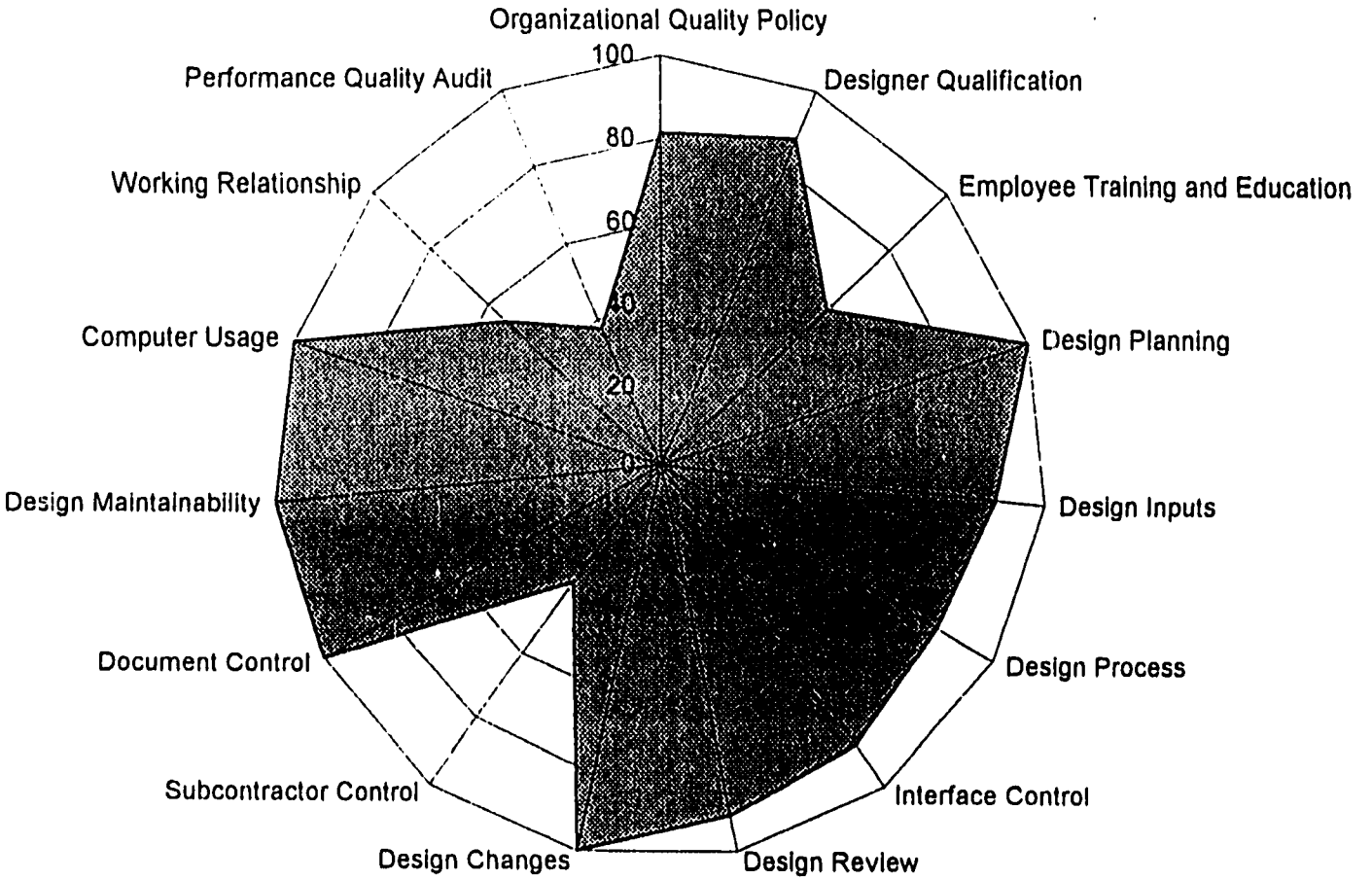
Service Quality Area = 69.82%

Service Quality Area of Organization 15



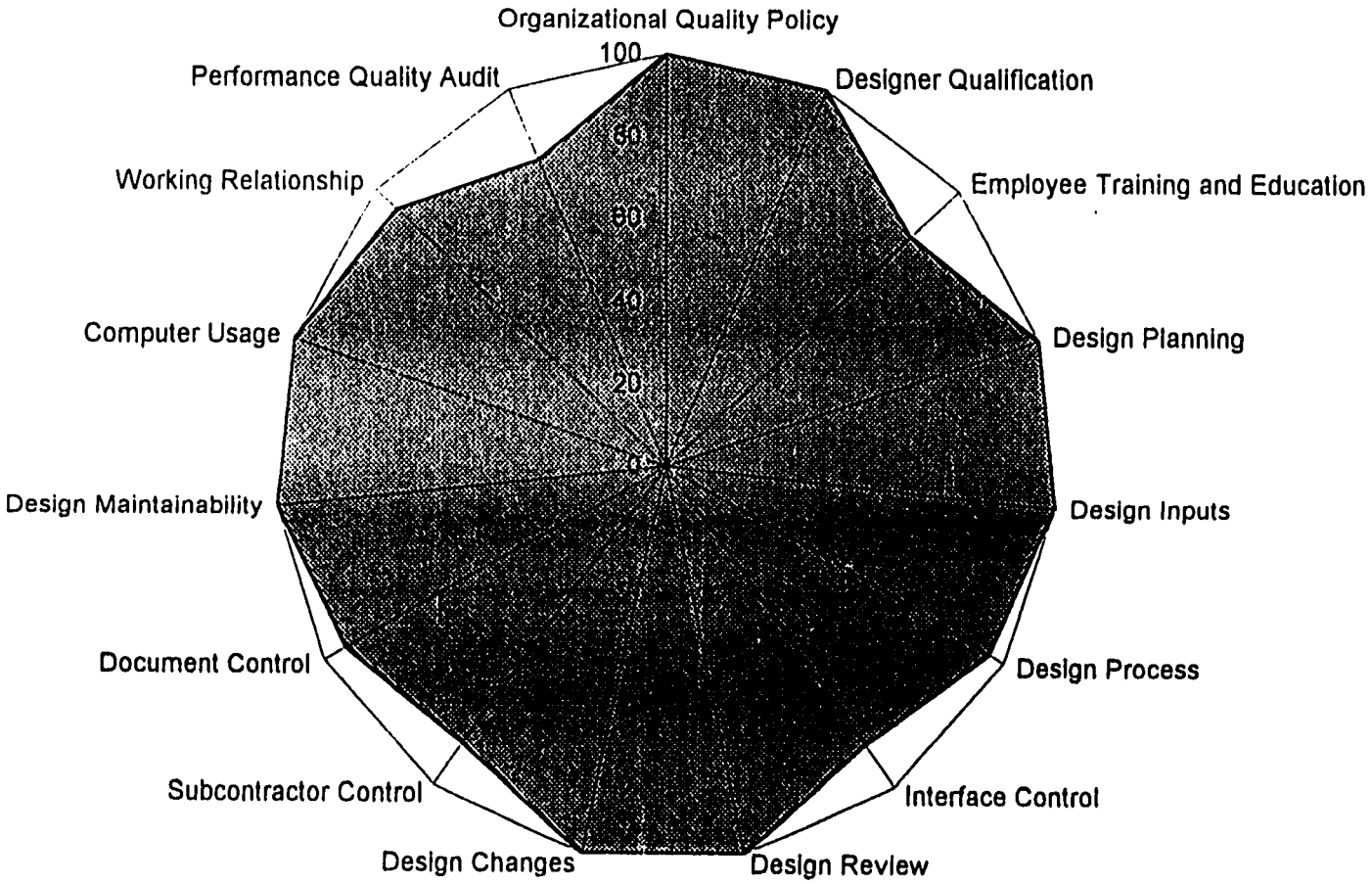
Service Quality Area = 71.49%

Service Quality Area of Organization 16



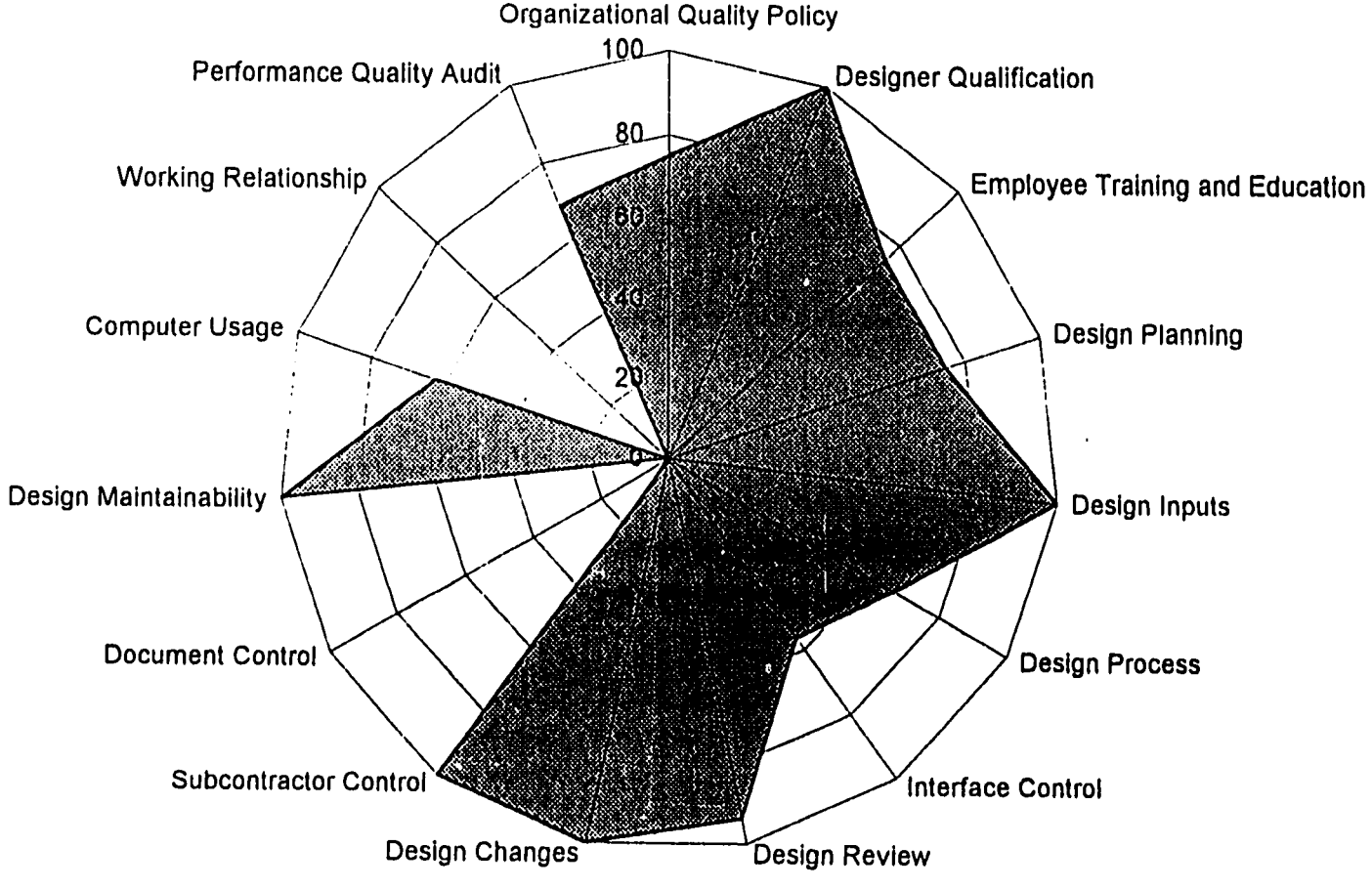
Service Quality Area = 80.31%

Service Quality Area of Organization 17



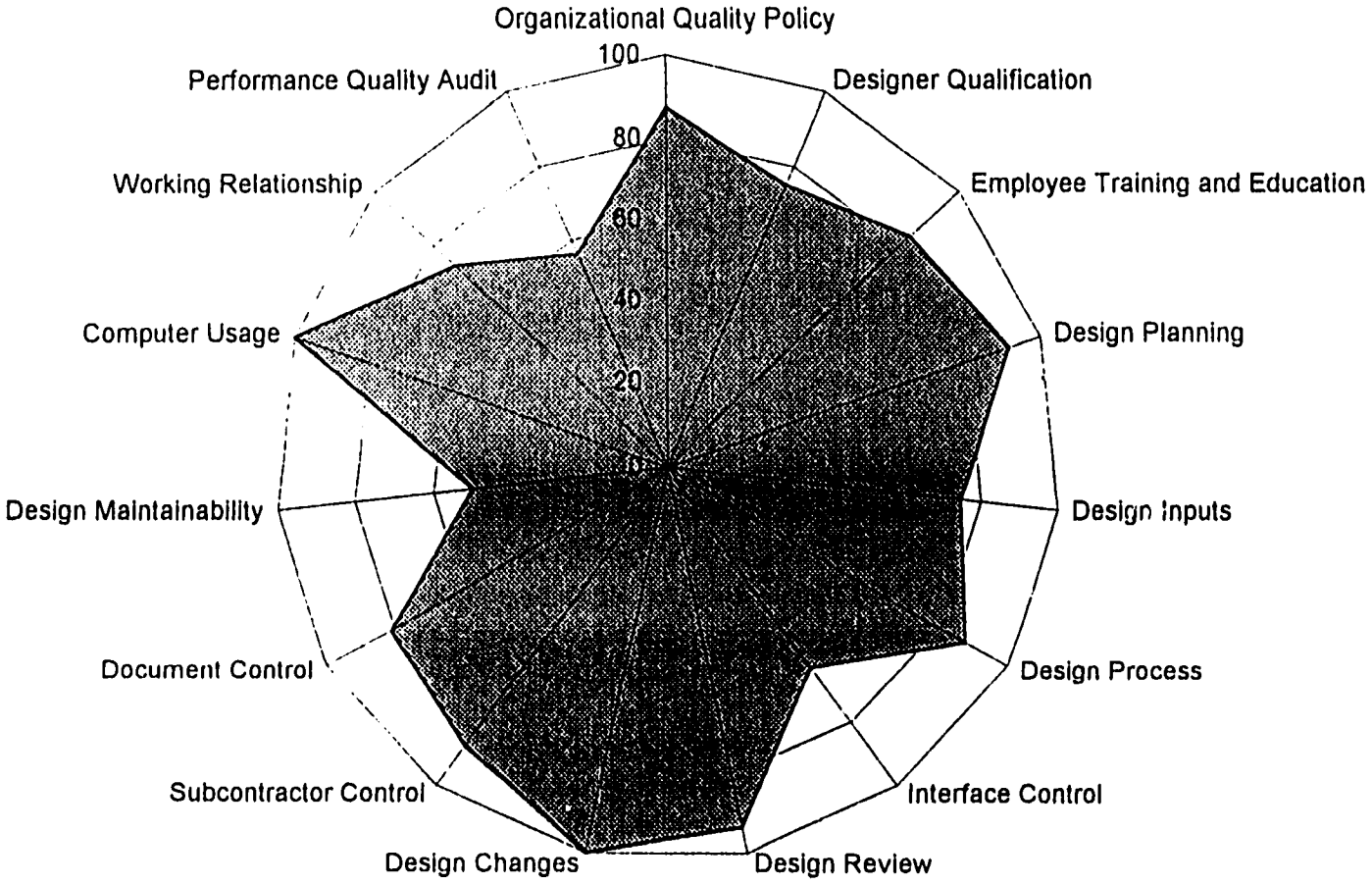
Service Quality Area = 94.80%

Service Quality Area of Organization 18



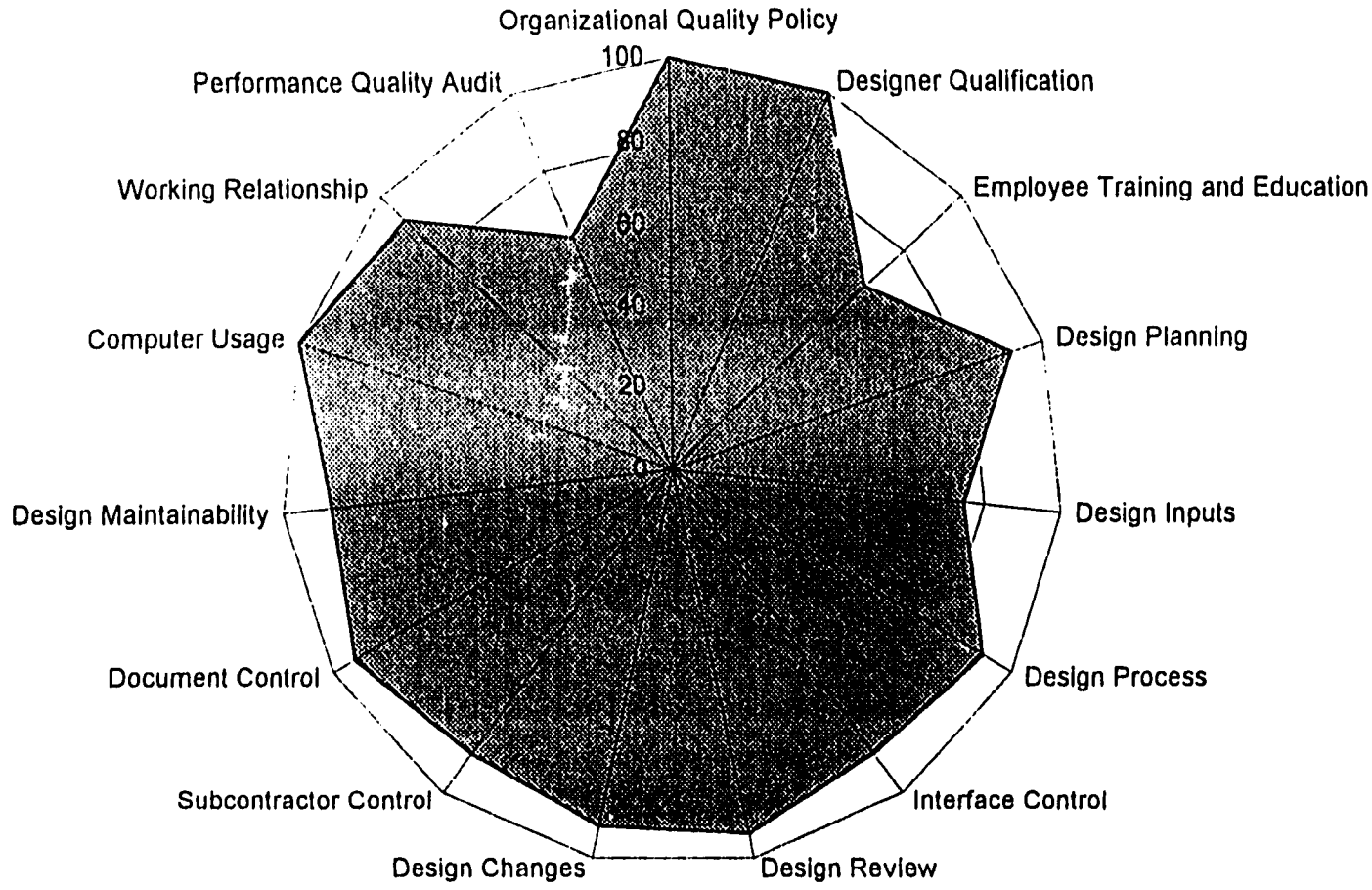
Service Quality Area = 71.53%

Service Quality Area of Organization 19



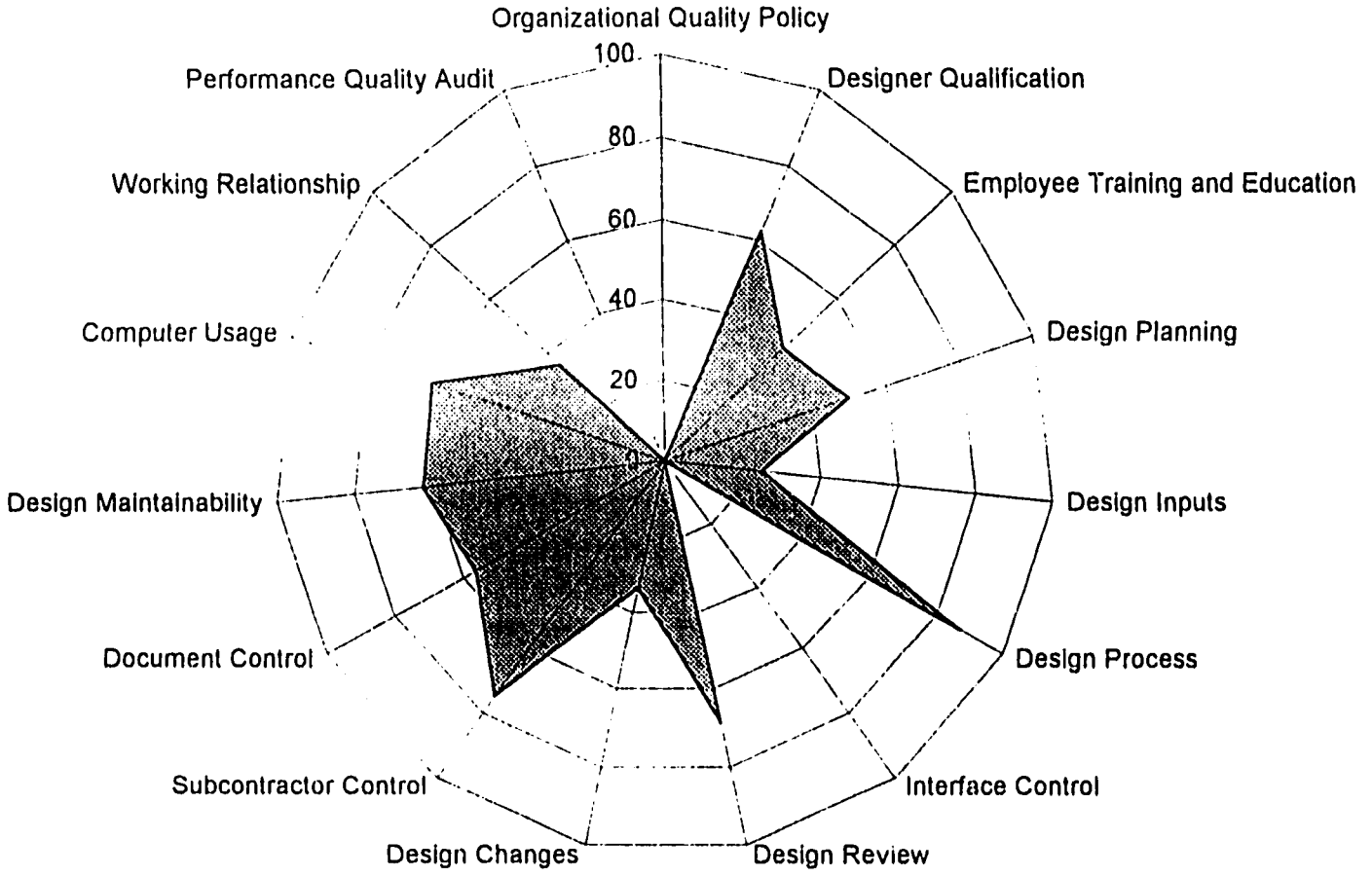
Service Quality Area = 80.26%

Service Quality Area of Organization 20



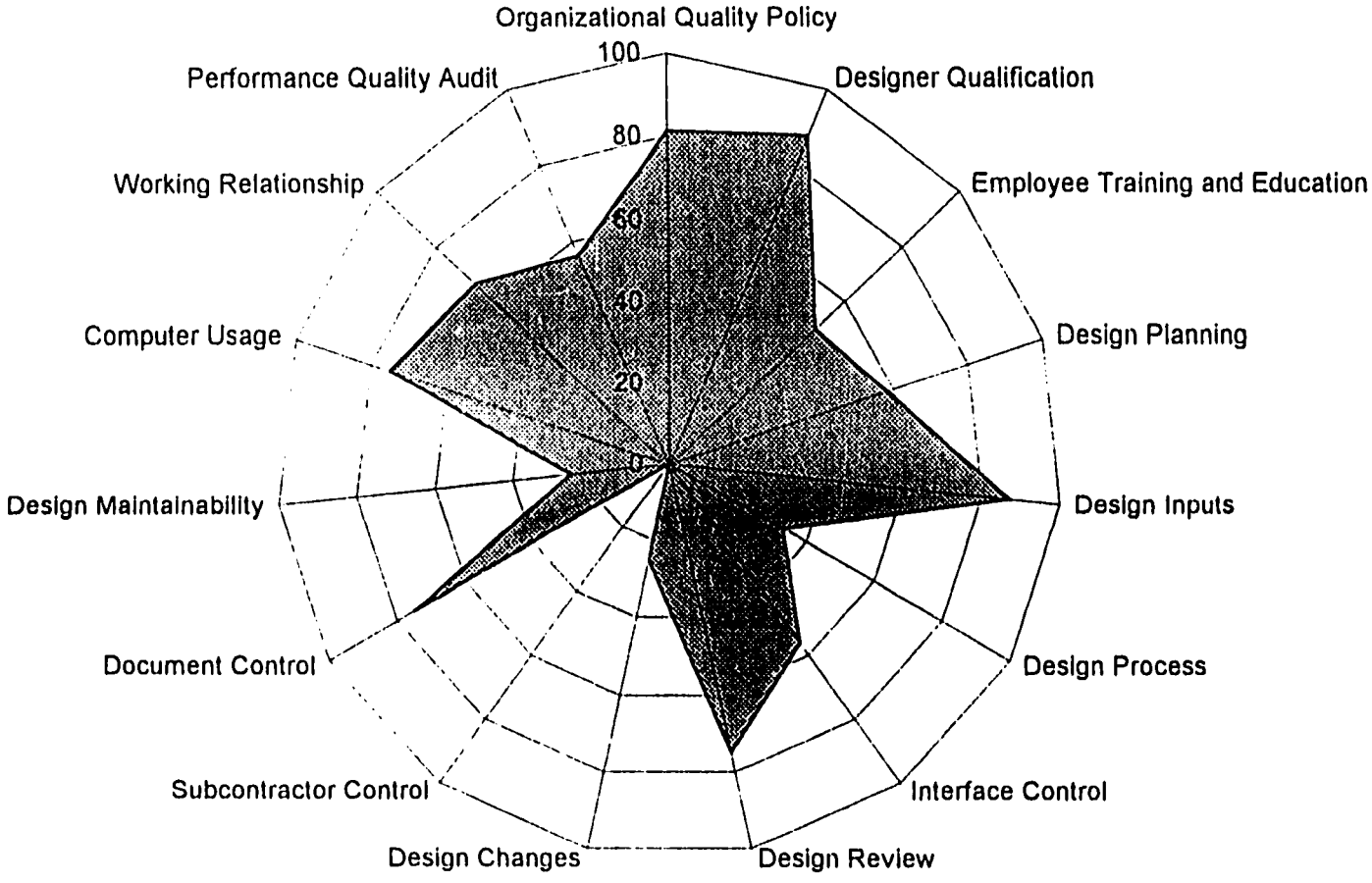
Service Quality Area = 88.06%

Service Quality Area of Organization 21



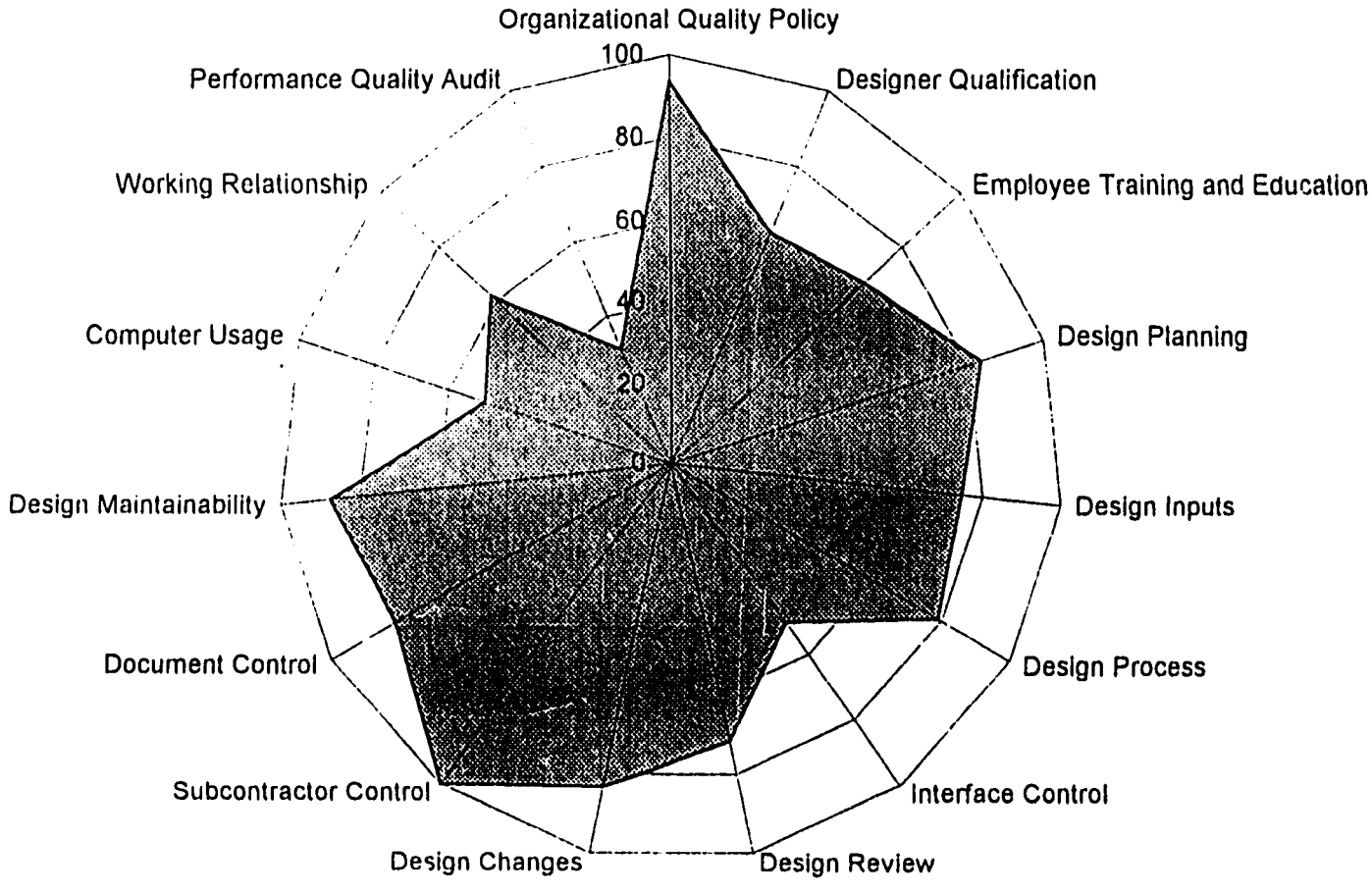
Service Quality Area = 44.05%

Service Quality Area of Organization 22



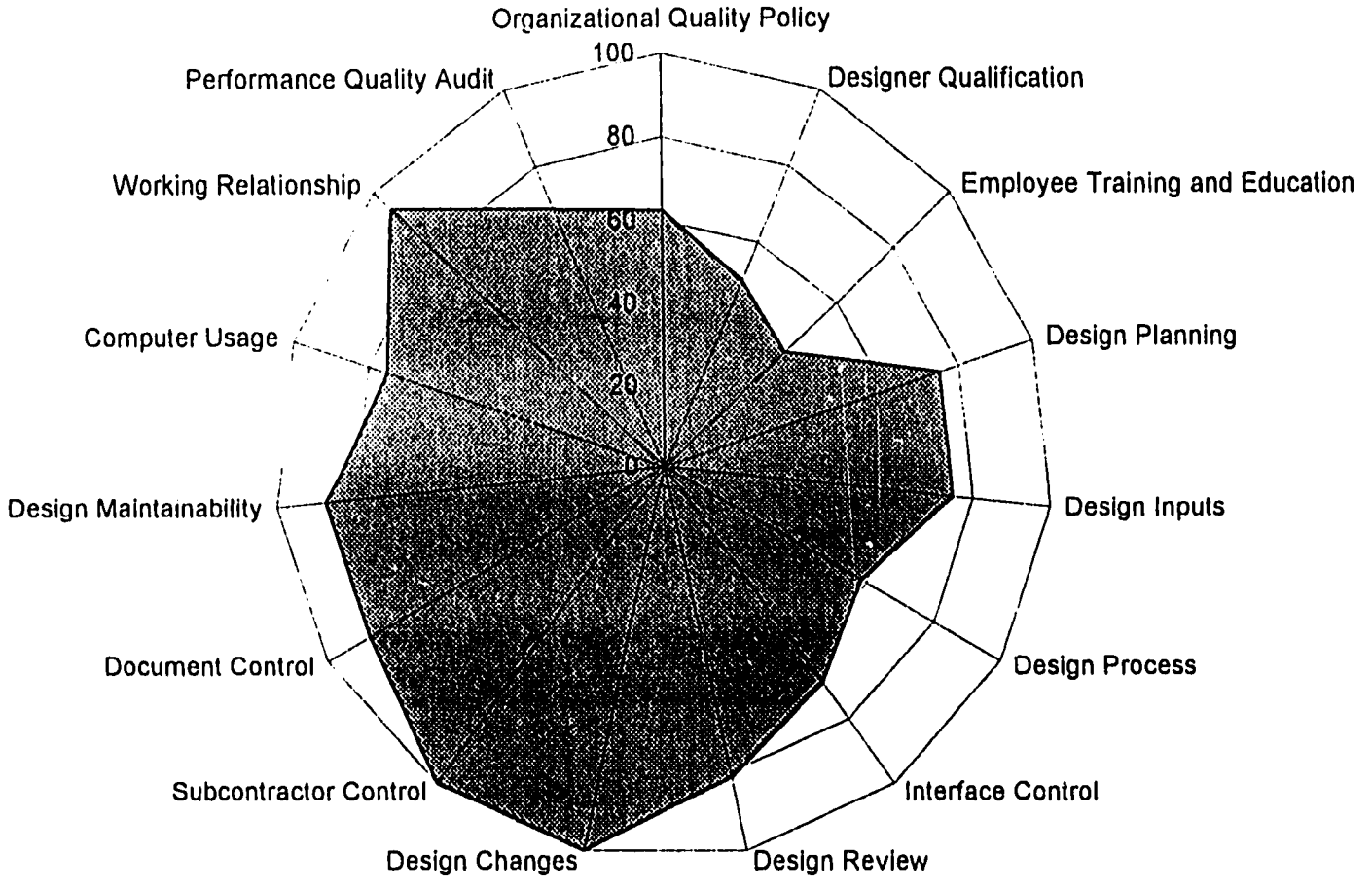
Service Quality Area =56.81%

Service Quality Area of Organization 23



Service Quality Area = 71.84%

Service Quality Area of Organization 24



Service Quality Area = 75.02%

Service Quality Area of Organization 25

VITA

Name: Gulam Farooq

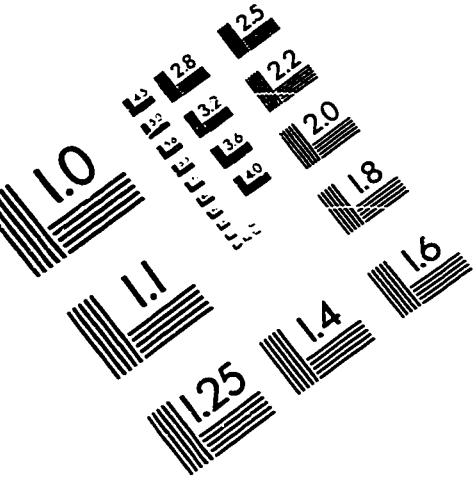
Father's Name: Gulam Quadir

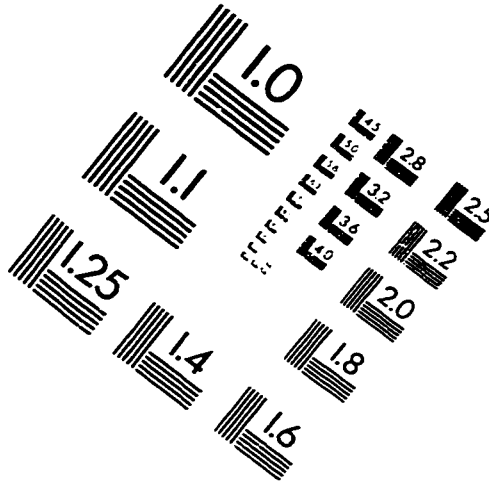
Date and Place of Birth: 9th February 1972 / Hyderabad, India

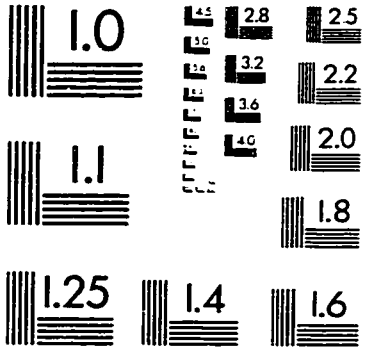
Mr. Gulam Farooq completed all his basic and secondary schooling from the International Indian School, Jeddah; he graduated from there in 1989 with merit. He then pursued his Bachelor of Engineering in Civil Engineering from Muffakham Jah College of Engineering and Technology (MJCET), Hyderabad, affiliated to the Osmania University, from where he graduated in the First Division in 1993. In 1994 he joined the Department of Construction Engineering and Management as a Research Assistant and attained his Master of Science in Construction Engineering and Management degree with an overall GPA of 4.0 in 1997.

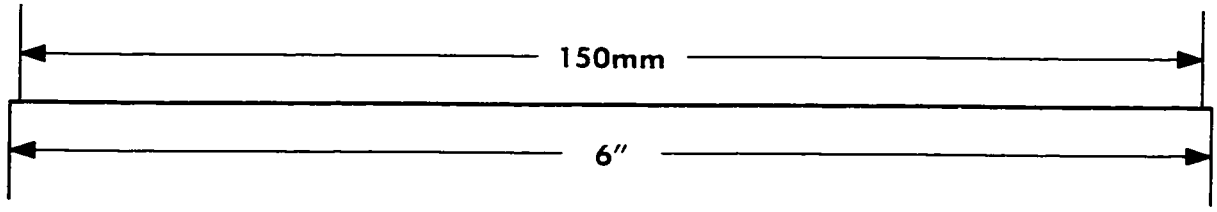
He is also an active member of a number of professional societies, some of which are: Saudi Arabian Quality Council (SAQC), Project Management Institute (PMI), The Association for the Advancement of Cost Engineering International (AACE – International), and the American Society of Civil Engineers (ASCE).

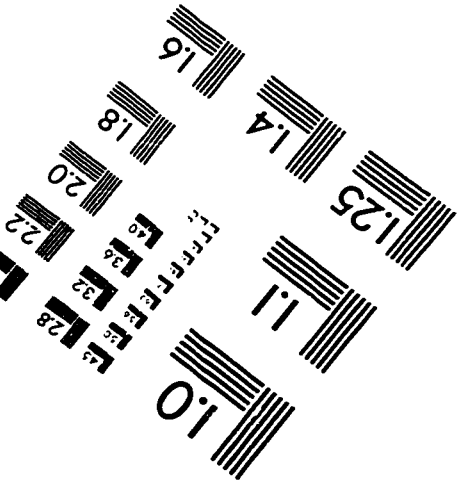
IMAGE EVALUATION TEST TARGET (QA-3)

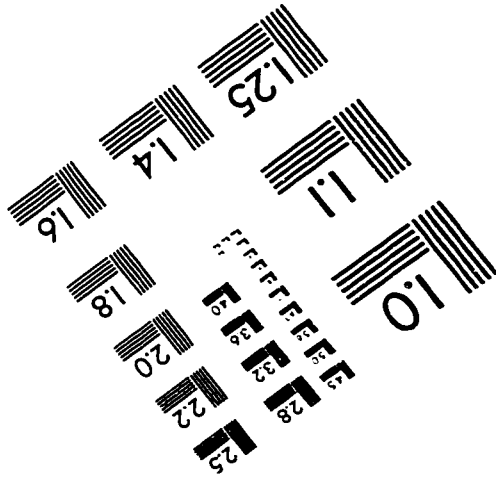












APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989